STATE OF MINNESOTA DISTRICT COURT
COUNTY OF RAMSEY SECOND JUDICIAL DISTRICT
- - - - - - - - - - - - - - - - - -
The State of Minnesota,
by Hubert H. Humphrey, III,
its attorney general,
and
Blue Cross and Blue Shield
of Minnesota,
Plaintiffs,
vs. File No. C1-94-8565
Philip Morris Incorporated, R.J.
Reynolds Tobacco Company, Brown
& Williamson Tobacco Corporation,
B.A.T. Industries P.L.C., Lorillard
Tobacco Company, The American
Tobacco Company, Liggett Group, Inc.,
The Council for Tobacco Research-U.S.A.,
Inc., and The Tobacco Institute, Inc.,
Defendants.
- - - - - - - - - - - - - - - - - -

TRANSCRIPT OF PROCEEDINGS
VOLUME 12, PAGES 2198 - 2369
FEBRUARY 4, 1998

P R O C E E D I N G S.

THE CLERK: All rise, Ramsey County District Court is again in session, the Honorable Kenneth J. Fitzpatrick now presiding.

(Jury enters the courtroom.)

THE CLERK: Please be seated.

THE COURT: Good morning.

(Collective "Good morning.")

MR. CIRESI: Good morning, ladies and gentlemen.

(Collective "Good morning.")

DR. CHANNING ROBERTSON

called as a witness, being previously sworn, was examined and testified as follows:

DIRECT EXAMINATION (cont'd)

BY MR. CIRESI:

Q. Good morning, doctor.

A. Good morning.

Q. Doctor, when we recessed yesterday we were about to discuss the actual construction or design of a cigarette, and do we have an animation to help in that, and also a blowup of the cross-section of a cigarette?

A. Yes.

MR. CIRESI: Could we have, for illustrative purposes only, Your Honor, Exhibit 30231.

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

MR. BERNICK: No -- I'm sorry, Your Honor. No objection.
THE COURT: All right. Court will receive 302 -- 301?
MR. CIRESI: 231, Your Honor.
THE COURT: 231, for illustrative purposes.
BY MR. CIRESI:
Q. All right, doctor. We have Exhibit 30231 on the monitor, and if you could describe first of all the various elements of a cigarette.
A. As we described yesterday, the cigarette contains and has all the elements of a -- of a drug-delivery system, and this morning I'm going to be describing to you how those elements are fabricated and how they're assembled and -- to produce the final product.
So on this graphic we can first begin with the tobacco column, which is the dark cylinder which contains the reservoir of nicotine, and as we'll find out, it contains various tobacco materials that are blended together according to certain specifications. And that tobacco column is then wrapped with a

cigarette wrapper paper in order to contain it and hold it in place.
The cigarette wrapper paper itself has certain characteristics that are involved in the operation of the cigarette, primarily certain additives that are put in the paper, and the paper porosity, how porous it is in terms of its ability to allow gases to exchange across its surface. Then on the majority of cigarettes sold today there is a filter section, and it consists of three elements. First there's a filter plug, and this is typically in most cigarettes a cellulose acetate material. You can think of it as if you had a large number of pieces of spaghetti lined up and parallel and you bundled them together. The cellulose acetate filters are strands of a polymeric material or a -- a natural product, cellulose, which has been treated chemically that are all bundled together so that the smoke that passes through the filter has to contact it, and as a result, some of the materials in the smoke are deposited on the filter as the smoke passes through it.
The filter plug, or the cellulose acetate material, has been itself contained in what's called the tipping paper, which is yet another kind of paper

that surrounds it and holds it in place, and also to help hold the filter material together, these fibrous strands, there is a plasticizer generally that's added to the filter material as well.
Now the filter has to be joined to the tobacco column and cigarette wrapper, and that's done by using what's called a -- a tipping paper, and the tipping paper is typically the brown or cork-like

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

paper that you see on the end of a cigarette, and it covers not only the filter plug and its plug wrap, but it overlaps the tobacco column and cigarette paper a small distance so that it can be glued on. So in the cigarette-making process, these two units, the tobacco column and the filter, are brought together, and the tipping paper is put around it and essentially they're simply glued together.

Those are the key elements of a modern cigarette.

Q. And have we had prepared for illustrative purposes an animation to show the varying types of tobacco that are used in the manufacture of cigarettes?

A. Yes. This animation will take us through the cigarette assembly and manufacturing process schematically, and we'll begin then.

So the first thing that's happened is that you need to bring together the various materials that are going to form the tobacco rod. Roughly speaking, about 60 percent of the material in the tobacco rod actually comes from the leaf of the tobacco plant. And in American blended cigarettes there are four primary kinds of tobacco that are used, there's a tobacco which is called burley, which is an air-cured tobacco, and it's typified, generally, as having a higher nicotine content than others and a lower sugar content. It also has -- tends to have a high what we call nitrate content, which is a nitrogen-containing compound. And to some extent the reason that burley is like this is because of the way in which it's grown, both in terms of the kinds of soils, the manner in which it's fertilized, the manner in which it's grown by the farmer, and the manner in which it's cured after the -- after the plant is harvested, since this is an air-cured tobacco. It's allowed to age, the leaves are allowed to essentially undergo further chemical processes that occur as essentially the leaf ages and certain chemical reactions occur, changing the chemistry of the leaf. So the burley tobacco forms one component.

Next is a flue-cured tobacco, also known as

Virginia or bright, Virginia from where it was -- either is or -- or was once grown, and bright referring to the color of the leaves, but the flue-cured indicates the manner in which it's aged. So once this kind of tobacco is -- is harvested, it's first of all grown in a different type of soil, it has a different kind of fertilization scheme. It's -- it's topped, for instance, so that the plant can't get as high as it might want to, which forces it to produce more carbohydrate, which in the end confers on it a higher sugar content. So it's a -- a median nicotine material that has relatively high sugar content compared with the burley. And then

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf
Source: http://industrydocuments.ucsf.edu/docs/skhd0001

it's cured differently. It's flue-cured, which means that it's -- it's cured at higher temperatures. In fact it goes through stages of higher temperatures as it's cured and prepared for cigarette manufacture.

Then there's a third kind of tobacco that's known as oriental, sometimes also referred to as Turkish. Tends to be tobaccos that are imported. They can be found growing in and around the Mediterranean countries. They tend to be moderate levels of sugar and tend to be a bit -- little lower in nicotine, and they tend to be very aromatic.

The fourth kind is the Maryland tobacco, which

is -- tends to be a more alkaline tobacco. It, too, has a -- like the burley, a low sugar content.

So these four kinds of materials are grown separately, they're harvested, they're aged in their own special way, and these are brought together in certain blends, a certain percentage of burley and a certain percentage of flue-cured.

It's burley and flue-cured that occupy the highest percentages in the blends, followed by the oriental, with generally a small amount of the Maryland. And each of the manufacturers have their own recipes in terms of how -- how they blend these different tobacco types together.

I should point out that even on a typical tobacco plant, the nicotine level varies from bottom to top, and so tobacco leaves are graded based on not only where they're grown and what kind of plant they are, but where the leaf came from on the plant.

So once the harvesting and the grading of the leaves are done and the purchasing is done by the -- by the manufacturer based on the kinds of materials that they would like to have in their -- in their cigarette, the leaves are taken to what's called a stemmery, and this is an operation where the stem -- which is what remains, looking up here -- is

removed from the -- what's called the lamina or the -- what we would think of as the leaf part of the material. Approximately about one-third of the top of the leaf is simply just cut off and considered to be lamina because the stem ribs are pretty small, and the bottom two-thirds, approximately, is taken to the stemmery where it's thrashed in such a way to separate the leaf material from the stems.

So we have now a portion of the tobacco column. We have a blend, if you will, of the lamina from four kinds of tobacco.

Now the stems themselves represent about 20 to 25 percent of the weight of the tobacco leaf, and so there is a -- an economic -- certainly an economic desire to try and use that material in tobacco processing, and indeed the stems are used. They have to be treated because if you see a tobacco stem, it's -- it appears just like a stem of a -- of a

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

plant, it's woody and doesn't look at all like the leaf, the leaf material, and so it has to be processed in a way that allows it to be incorporated into the cigarette blend and into the tobacco which actually goes into the cigarette. So now we have two kinds of material, we have the lamina material, we have the ribs and the stem.

Now the cigarette manufacturers are -- are quite adept at reducing the waste during manufacturing; that is, the dust, the broken leaves, materials that might spill out on to the floor. This material is all collected together continuously and fed back into the -- into the process to incorporate it to make total -- essentially as much as total utilization of the product as they can. So these materials, the -- the waste materials, if you will, even cigarettes for one reason or another that are knocked off the manufacturing line, are returned to the -- are returned to the process. So there's very, very little waste.

So these ribs, stems and these sweepings you see aren't exactly -- and they're not tobacco leaf, so they can't be incorporated at this point into the tobacco makers, they need to be processed, and to do this, they're processed into something that's known as reconstituted tobacco. As I said, the lamina, the actual tobacco leaf material from these four kinds of tobacco plants constitute, let me say, roughly on the order of 60 percent or so of what you find in the tobacco rod. Maybe a little more, but that's roughly about right. So another fraction of the remainder, another 20 percent or so is comprised of this

reconstituted tobacco, which is made from the stems and the waste materials that you encounter in processing. So in order to make this, in a sense, equivalent to the lamina so it can be processed like the lamina, like the leaf material, these waste products are turned into what would look to you and me like paper, like a -- sort of like a brown paper bag. Because you see, these materials are themselves plant materials. Just like a tree is turned into paper, these materials can be turned into a paper. And these paper materials or sheet materials, as they're sometimes called, fall into the name of "reconstituted tobacco."

Now there are two primary ways that you can make reconstituted tobacco -- there's actually more, but there's -- there's two that are -- that are -- are used typically in industry. One is called band cast reconstituted tobacco, and the other is called paper reconstituted tobacco.

The band cast reconstituted tobacco uses very, very fine materials for its feedstock, so either fine dust, very fine particles or stems and sweepings that have been ground up into a very, very fine powder.

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

In effect it looks and feels very much like a powder material.

Now the way paper is typically made is you take your woody material, your fibrous material, say, from the tree, and it goes through a process known as pulping where the cellulosic materials are dissolved, they're made into a slurry or mixture, and they're spread out on a moving belt and dried. This is how paper is normally made, paper that you're writing on, newspaper and so forth. In this band cast process, because of the very, very small particles that are -- that are being used, they tend not to have long fibers because they've all been ground up, and so it's difficult to simply slurry this material and cast it out onto a moving belt and dry it because it doesn't have a tendency to hold itself together. So what is used in the industry is -- is ammonia compounds such as diammonium phosphate or ammonium hydroxide, or both. These are compounds that contain ammonia which are added to a mixture of this dust and water, and what these compounds do is they're thought to liberate certain constituents, certain chemical constituents in the tobacco material in such a way that when you take this slurry and -- and allow it to be spread out on a belt and you draw the -- you draw the liquid out and dry it, these materials that have been liberated by the ammonia compounds act sort of

as a molecular glue to hold the paper together.

So the key thing to remember on band cast is that it's the small particles, that there's a chemical addition of ammonia compounds that serve as -- help serve to promote the gluing process that holds this paper together.

So this material is then spread out onto a moving belt and it goes through dryers. The fluid is removed. And so coming out the other end of the process is something that looks very much like a big piece of paper. It may be eight or 10 or 12 or 15 feet wide coming off this belt. And typically it's chopped up immediately after it's made into fragments that are, oh, about this size, about four by four inches, something like that. But you can see that at that point it's starting to look like a tobacco lamina, a piece of the tobacco leaf, so that it has some of the same sort of textural characteristics so that it can be included with the leaf material, and then these are processed together.

Now in the paper process, which is another way of making use of these waste materials -- the materials aren't the really small particles, they tend to be larger materials, they tend to have fibers in them so that you can actually, for all intents and

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf
Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

purposes, simply just run it through a paper machine just the way paper is made. And you do that by, again, making a slurry, a liquid slurry of this material. And it goes through some rendering processes where it -- the -- the fibers are -- are treated so that they will be in a physical form that will allow the paper to hold itself together once it's dried.

And this is run through essentially a paper machine, and when the paper is -- is -- is made, certain additives are put on the paper, and these additives include things like sugars, ammonia compounds, dispersants, flavor additives. So these are -- are -- are put on one or both sides of the paper, and then that's dried again. Looks like a paper-coating process.

You see this all the time. If you read National Geographic magazine, you'll notice that that paper looks very different from news print, and that's because it's a coated paper. After the paper was made, a coating was put on it. This is much the same thing.

So what this does is it gives the tobacco and cigarette manufacturers an opportunity to add back material that came out of the tobacco when they put

the water in it. When they put the water in to make the slurry, some of the water-soluble materials would come out, such as the nicotine, so that's added back in the process.

So coming out of this machine is a -- another very wide band of paper which is then chopped up and then treated very much like the leaf lamina. So for companies like Philip Morris and Brown & Williamson, which use both the band cast and the paper reconstituted tobacco process, they have these two materials to blend in with the other four.

So you can begin to see that making a cigarette is very much following sort of a recipe: so much of this kind of tobacco, so much of this kind, so much of this kind, so much of the band cast reconstituted tobacco, so much of the reconstituted tobacco, to make the full, final blend.

We're not even done yet. So those are some of the ingredients that -- that go into it at this point.

So what we'll do is just demonstrate a paper-making process, because in the paper-making process the paper is made -- here it comes -- the paper is made from the -- in the paper-making process, and then the additives and extracts -- when

I say "extracts," I mean this is the material that came out when they were -- when they were taking these stems and sweepings and so on and they put it in -- in the -- in the water, you just can't make a

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

paper with that, we've got to take some of that water away. You have to have a certain amount of water in there, but you can't have too much because it's too thin, it's not -- it's not thick enough. And so they save that extract that comes out because it does contain materials that were in the tobacco, and they bring it over and they put it into -- schematically into this tank. And they add it back along with other chemicals, as I said, such as the sugar and such as the ammonia compounds.

So then it comes out of this bath and then it goes into a dryer, and now you have your reconstituted material which contains the ribs, the stems, the sweepings and these additives, and it then is cut up and added to the tobacco column.

Now there's yet another kind of material that goes into the cigarette, and this is called expanded tobacco. Expanded tobacco offers the manufacturers a means whereby they can use essentially less material, less tobacco in making the cigarette, but still have a cigarette of the appropriate length and of the

appropriate firmness. And I think the -- the best way to -- to explain expanded tobacco is simply that the tobacco is cooled or is -- is -- is mixed with a liquid, typically under high pressure. Now these liquids could be carbon dioxide, which becomes a liquid at -- at a very low temperature and a very high pressure, or you can use ammonia. Ammonia has been used, or freon, freon has been used, which is a chlorofluorinated hydrocarbon known as a CFC. These materials, these liquids, carbon dioxide or freon or ammonia, are used essentially to freeze the -- freeze the tobacco.

This material is forced into the tobacco matrix and it's frozen, and then as the pressure is released and as the material warms to room temperature, it expands; that is, it fluffs. It's not unlike popping popcorn where you start with a little -- couple kernels and you end up with a big bag of popcorn. So you have the same mass that you started with, it just occupies more volume. And this is the concept of expanded tobacco. You can get anywhere from 50 percent or greater increase in volume. So you can see, then, that the manufacturers can put this material into the tobacco column, which takes up less room so they can use less material. Because as you

might expect, they are operating under economic constraints, they're trying to be efficient, and as long as the reservoir contains a sufficient amount of drug and nicotine, there's no use having more than -- more than you really need there, because it will simply go to waste.

So the expanded tobacco is also added -- and this should be expanded tobacco -- and so you have all these materials that comprise the tobacco rod.

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

And as you also might imagine, the manner in which a character is given to cigarettes depends on how these blends -- what recipe is followed in putting these blends together.

Now one thing I should say is that the leafy material or the lamina material is treated before it's put in the tobacco column. The burley tobacco, when it comes into the plant, is typically cased. And this is a terminology that the manufacturers use to represent the addition of chemicals to the burley lamina. As I said, burley is low in sugar, and so the typical additives -- and again, each company has its own secret formulas and recipes, but typically the additives would include sugar, licorice -- tobacco industry is the largest consumer of licorice in the country -- cocoa, chocolate, in some cases

ammonia compounds such as urea. Not in all cases, but in some cases.

So the burley tobacco is -- is treated a little bit differently than the others, or the burley and Maryland are treated a little bit differently than the others, than the oriental and -- and flue-cured.

Now some of the oriental and flue-cured is also cased in some operations as well, so that again in order to tailor the blend, the manufacturers have an opportunity to add chemicals to the tobacco as it's being processed and prepared for the final blending operation. Once the final what's called "cut filler" is achieved -- and this is where all these streams have come together, the material has finally been chopped up to a -- a determined what's called "cut width "-- how wide are the little strips. If you take a cigarette apart and you look at the -- and it's an informative thing to do -- if you look at the pieces of material in there, you'll see that they're all fairly uniform in size, and this is because the material goes through cutters that cut it to these -- to this particular size.

Now the final -- we're not done yet. Once you have this final what's called "cut filler blend," there's generally one more operation, which is it's

put into a flavor spray operation where typically a suite of flavors, generally in quite low concentrations because they tend to be natural oils, natural flavorants, any number from a half a dozen to a dozen or more that are mixed together, and the tobacco cut filler goes through a large rotating drum which is rotating, and generally it's being sprayed on like a shower from a shower head onto the tobacco, and then it comes out. The moisture content is watched very carefully. And then these are put into large bins, and they're held there until that bin is used for the manufacture of a particular cigarette.

So as all this material moves through the plant it begins to gain character, if you will, that

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

ultimately, when it's at the end, it will become a Marlboro Light or a Marlboro Red or a Pall Mall or Lucky Strike or -- or something of that nature.

Now the tobacco material is taken from these large storage containers when the -- when the cigarette is ready to be manufactured, and typically it's pneumatically conveyed through pipes to the cigarette manufacturing part of the plant. And it goes through -- into machines, cigarette-making machines, which dispense a certain amount of the tobacco, typically on the order of, say, three

quarters of a -- of a gram. But rather than making each tobacco separately, what's done is the -- the paper, this paper that goes around, it comes out in a very long strip and the tobacco is just put on this strip. If you can imagine, the strip is moving by and the tobacco just falls on it. And then it's rolled. So in fact what you really end up with is a really long cigarette which is then chopped up to make the cigarette body. So you have the paper, it's continuously running, tobacco is continuously dropping on it, and then the machine folds it and glues it, and then it's chopped up into the proper length.

So we have a few additives that are put in the cigarette paper. Typically they're additives that control the rate at which the paper will burn and also give some color or character to the ash that's formed when the cigarette burns.

Now this is wrapped around the rod. As I said, this is a continuous process. And having done that, we need to add the cellulose acetate tow, which is the plug which is the filter material which is manufactured in -- nearby to the cigarette-making machine. The plug wrap is put around it and the tipping paper is added, and then they're joined

together and you have the final product.

There's one other step, however, that is used in many cigarettes, and that is to add ventilation holes to the filter portion of the cigarette. Now the ventilation holes can be made mechanically, by basically poking a hole, or by electroperforation, which is like essentially hitting it with a little light-beam strike, or I think as is most often done now, the cigarettes basically pass in front of a laser and the laser, as shown at least schematically here, burns the hole pattern into the cigarette.

So if you -- and I think Dr. Hurt, as I understand, showed you this, where you take a filter apart and hold it up to the light and you can see the holes. And some -- some filters have one line of holes, some filters have two lines of holes, some have more; some have bigger holes, some have smaller holes, and some cigarettes you just simply can't see them. Now this is for the purpose of allowing air to

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

come in and dilute the cigarette smoke stream. And so this happens during the cigarette-making process, and when that is done, the cigarette's ready to smoke.

So when the cigarette is lit, it begins to burn, and at the point where the cigarette is burning we

have a combustion zone where oxygen is being brought in, and it's literally combusting the tobacco material, and this creates a terrific amount of heat. Locally at the burning column the temperatures can be eight hundred or nine hundred degrees Centigrade at the point where the cigarette is actually burning. And so we have this very hot combustion zone and there are gases formed, the combustion gases. The combustion gases could be carbon monoxide on carbon dioxide and so forth. And right behind the combustion zone and surrounding the combustion zone where the material is being heated we have a region -- if you can imagine if you're in the tobacco rod and someone has lit it on fire, and that -- that front, that combustion front is moving toward you, you're going to get warmer and warmer and warmer, and if you don't leave, you'll be combusted. But what happens is a number of the -- of the chemical constituents in the -- in this tobacco matrix of this -- all these materials that have been put in, they start leaving the tobacco material. They -- before they really burn, they get ejected out of the material, and they can undergo chemical decomposition, thermochemical decomposition which is called pyrolysis. And what "pyrolysis" means is they

in a sense undergo a chemical change but they don't, as we would think of it, burn up the carbon dioxide and water. They're not -- what we say it in chemical terms is they're not completely oxidized, they're just partially combusted.

Now what this does is it causes a tremendous number of new chemicals to be synthesized, because these partially-combusted chemicals are now in a very reactive atmosphere and they're -- and remember how I described how a molecule is like a Tinker Toy where they're falling apart and they're coming together and they're falling apart? And this is why cigarette smoke contains, in some, so many thousands and thousands and thousands of chemicals, because you're taking a very complex material that already has a huge number of chemicals in it, heating it up, and allowing even additional ones to form.

So in this pyrolysis zone, it's a -- it's a place where materials are not completely burned up, is the way to put it, and you have this what we call pyosynthesis, creation of new materials.

Now even a little bit further, when the -- when it's just starting to get warm, there's this moving front that's coming to you and you sense the heat, if

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

you are a semi-volatile chemical; that is, if -- if

you have a means of essentially evaporating out of the material, you -- you will when it gets warm enough, and we call this distillation. But what it is is it's simply the transfer of a chemical from the solid material -- we call it the solid phase, the tobacco -- into the vapor.

Now nicotine is an example of just such a material. It has a reasonably high volatility. So that as the tobacco material is warmed and -- and continues to warm up, it will vaporize, it will leave the solid phase and go into the gas phase, but it won't be chemically changed because it didn't get so hot that it actually fell apart and recombined into something else, and it didn't get so hot that it actually burned up.

Now some of the nicotine will burn up, some of the nicotine will be taken apart and made into something else, and some of the nicotine will simply come off the tobacco unchanged. And this is true for a wide variety of the chemical compounds that one finds in tobacco.

So the three processes you want to sort of keep remembering is the sort of complete combustion or burning, then this pyrolysis or pyrosynthesis of new chemicals, and then the distillation process

where materials just come off unchanged, get into the smoke and are carried with it.

Now what is smoke? If you're sucking on this tobacco rod and drawing air in through the fire cone, the combustion products, which are very hot, including the materials that pyrolyze, the new chemicals, including the ones that distilled off, begin to move toward your mouth, but as they do, they go through the tobacco rod which is now quite cool, so they condense. At least those that can condense will, much like a fog. And so these little liquid droplets start nucleating all over the place inside this tobacco rod when it's cool enough, and this is what forms those little liquid droplets I was telling you about yesterday, the aerosol droplets that comprise the smoke.

And so when you draw this in, the smoke really consists of billions and billions of these little liquid droplets being conveyed in this moving gas, and the moving gas contains some of the chemicals that didn't go into the droplet as well as gases that don't condense like carbon monoxide and nitrogen and oxygen. So this is what goes through the tobacco rod, through the filter and into your mouth.

Now of course as it's going through this tobacco

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

rod and through the filter, these gases and these particles are encountering the material in the tobacco rod, and when they go through the filter they encounter the material in the filter, so some of them are removed. They're removed because they either hit the material and stick to it or because they -- they move in a -- as they're moving toward your mouth, they also move in the -- what we call the radial direction, and they might -- might find a surface or they might find a fiber in the filter and they'll stick. So that serves to take out some of the material.

Now this becomes even more complex because, as you might imagine, some of this moves through the tobacco rod and deposits some of these little liquid droplets. When the fire comes, finally gets down to them, they all come off again. And so you sort of have this marching effect of -- of materials that are redepositing, being elevated out into the smoke stream again and redepositing. It's a very, very complex process that's going on here.

So finally the smoke is taken in and it's -- it's taken into the mouth, into the nasal cavity, and it contains, as I said, thousands and thousands of chemicals, some of which are out here in the -- what

we call the gas or the vapor phase, that's like what's around us here in the -- in the -- in the air in the courtroom, and also contains little particles. And I think the best way still to think about it is like a fog. What you see when you see a fog are the little droplets of water. So here we have little particles, little liquid droplets, which also contain thousands of chemicals.

And some of these chemicals are what we call partitioned between the liquid droplet and the vapor phase, so you will find nicotine both in these particles and you'll find nicotine out here in this vapor phase.

Q. Thank you, doctor. I'm going to change tapes and then ask you some questions on -- I'm not leaving you, I'm just stooping down here.

A. Maybe I'll preface, while he's doing this, what's about to happen. I'm going to show you a video of an actual cigarette-manufacturing process so that you can -- you can connect with what you -- what I've told you verbally and what you saw in the animation with the actual machinery and operations that one would encounter in a cigarette-manufacturing facility. And what we'll see first is a band cast process, making this sheet of paper using the very,

very fine particles, and then we'll see a paper-making process, and then we'll see the actual cigarette blending and manufacturing process.

MR. CIRESI: The record should reflect, Your Honor, that the previous animation was Exhibit

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

30255, and we'd offer that for illustrative purposes. And --

MR. BERNICK: There's no objection to that.

MR. CIRESI: The next one coming up is Exhibits 30256 and 30257.

MR. BERNICK: There's no objection to this, Your Honor.

THE COURT: All right. Court will receive 30255, '56 and '57 for illustrative purposes.

MR. CIRESI: It should be up, doctor. I've switched control to you.

THE WITNESS: Okay, give it a try.

MR. BERNICK: I'm sorry, Your Honor, I believe those were tendered for demonstrative purposes only; is that correct?

MR. CIRESI: That's correct.

MR. BERNICK: And so received?

THE COURT: That's correct. And received in that way, yes.

A. Okay. So the first thing that we'll see is a

band cast manufacturing process, if Mr. Ciresi was able to handle the technical issue here.

Q. If not, I have a technician in the audience who will help.

I'm not looking at defense counsel.

(Laughter.)

A. I'd suggest you seek some --

Q. Is it up?

A. -- some assistance.

Q. Need a little bit of time to boot it up.

While we're waiting for it to come up, doctor, can you turn to Exhibit 30151.

THE REPORTER: Mr. Ciresi, is that 30151?

MR. CIRESI: 30151.

BY MR. CIRESI:

Q. And is this an illustrative exhibit of some of the additives that are added to American cigarettes?

A. Yes, it is.

Q. And in your review of the formula documents of the defendants, were you able to ascertain that additives of these natures were added to American cigarettes?

A. Yes, definitely. As I said, every -- every cigarette that's manufactured according to a particular brand has a set of specifications for the

casing material, which is added to the -- either to the material, the Maryland or to the flue-cured tobaccos, and in the final flavoring step, and these are all listed out and specified very carefully for each of the -- each of the cigarettes that is made. And this gives you an idea of the suite of, I don't know, five or six hundred kinds of chemicals that are added to the cigarettes during the manufacturing.

MR. CIRESI: Your Honor, we'd offer Exhibit 30151 as a summary under 1006.

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf
Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

MR. BERNICK: Your Honor, we have no objection to its being displayed to the jury in the fashion which it was, as a demonstrative. To be able to know whether it's an accurate summary or not, we'd have to go back and compare it. We frankly have not had the opportunity to do it; didn't think it would be offered for that purpose. So I'm not -- not prepared to really stipulate to the admissibility. But we can go ahead and do that and let the court know.

THE COURT: Well we'll allow it for demonstrative purposes at this time, and subject to your review.

MR. BERNICK: Okay.

THE COURT: You can move to strike it after

if you find something inaccurate.

MR. BERNICK: Thank you, Your Honor.

MR. CIRESI: We think we have it, Your Honor.

THE WITNESS: Yeah, looks pretty good.

A. Okay. This is the receiving area. Remember, this is for the -- the band cast process. And the materials that are brought into the -- are brought into the plant come in large containers such as these that we see here, and this will contain the feedstock material for the band cast reconstituted sheet material. This could include stems, although for stems to be used, they're going to have to be ground up to be very fine, or it could be dust and very fine particles that have been collected in the manufacturing plant where the cigarettes are made or in the plant where all the blends are put together.

As I said, there's a -- quite a bit of effort made to include the total -- the total material into the -- into the final products so there's very little waste. So this is the receiving area where the various materials are -- are brought in and prepared for the band cast process. They're put into these --

These big boxes you saw are put into these large bins, and these bins basically lift up those boxes

and dump them in such a way that they can be conveyed into the process. This is a -- basically what's called a hammer mill. And in this machine what you saw being dumped out of the boxes is passed through this machine, which literally pulverizes the material into a dust. So if you're feeding stem material or broken leaf material or whatever, once it comes out of here, out of this machine, it's -- it's very, very fine powder.

Then this material is conveyed and put into large tanks or storage silos where it's held, and then it's taken to what's called the slurry preparation area. So you can imagine you have this powder, you put it into a tank, and now you add ingredients to the tank. So you'll be adding some

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

water, and in this case you can see you're adding ammonia. And remember, I indicated that the -- in this case the ammonia appears to be required in order to create the molecular glue to hold the material together. So the ammonia or the ammonia solution is contained in that particular tank. Then there's other tanks that contain other materials that are going to be put into this slurry, into this mix.

You can think of it sort of like, you know, making a cake or something. So you see this tank has

a material called isosweet, and this is a sugar material. Propylene glycol is a material that is being used as a humectant or a moisture-retaining material. And this is a glycerine head tank. Another chemical in -- that little tank is a flavor tank. Then you have the ammonia tank. So these are all mixed with the slurry and then the slurry is put into an aging tank where it's -- it's held so that the chemical reactions can occur among all these ingredients.

Then after it's aged for an appropriate amount of time, it's then cast onto a stainless steel belt. And you can get an idea of the consistency of this material right there. That's what's cast onto the belt. And that will become a paper product once it is put onto the belt and then goes through a series of dryers.

Here you see it coming out of the dryer. So that's what the paper looks like, it's a dark -- a dark material in this case.

And these are the dryers. And what's happening here is that the paper is moving along and then it comes back and loops around and comes out dried and in the form of a -- of a paper. So you're putting basically a slurry down on a stainless steel belt and

then drying it.

And now what -- what we'll see as you look inside, you'll see a conveyor belt conveying this paper material. It's now been cut up. So this is the band -- this is the band cast material cut up, and now that can be taken and blended in with the other ingredients. But since that doesn't happen at this particular location, it's stored, it's packaged in these round barrels. A huge cylinder comes down over the round barrel and those little pieces of paper that you saw in the last frame fall down through this large cylinder, then a big ram comes down, sort of like a trash compactor in your house, and smashes this material into this container to compact it. And here comes the ram back up. Very much like your trash compactor.

This lifts off, and now this is full of band cast recon that is chopped up into those little sheets that we saw. You can see it.

In the back there you see another one filling.

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

There's another cylinder behind there that's filling a container.

So this container now, which is full of the band cast material, is taken over to this station where a top is put on it. And the top is pressed in. And

STIREWALT & ASSOCIATES
P.O. BOX 18188, MINNEAPOLIS, MN 55418 1-800-553-1953

then this material can be taken to the cigarette manufacturing facility and used as part of the -- of the blend.

Now we'll look at the other kind of reconstituted process, the paper process. And again, the material is brought in in these large containers. And remember, this is the process now where you don't have to grind it up to a dust -- or they don't grind it to a dust, they use larger particles. Again, they use stems and broken leaf and waste material.

Now there's a good picture of stems. It looks just like you'd imagine a stem to look like. They're, oh, I don't know, an inch or inch and a half long. And they come in in these large containers. And of course I couldn't put something like that into a cigarette, so this obviously has to be treated.

And these are then -- these various materials are dumped using these automated hoppers which lift them up and dump them into the process flow stream, so the various kinds of materials, the stems and the waste, the broken leaves and lamina are put together in a -- in a proper proportion according to the recipe that they're -- that they're following. And you can see these are all waiting to be dumped.

And now we go into the next part of the process

where that dry material that has been dumped has basically a pulping solution added to it that causes -- and these are what I call the pulpers, these tanks are where that material is mixed with liquids that cause it to basically turn into a mush, the best way I can describe it. Very much -- this is very similar to the paper-making process for any kind of paper. So in these -- in these large tanks the material is being chemically broken down, and it looks very much like a mush, which is then passed through a pipe called the tobacco stock pipe, and that goes overhead.

It's pumped overhead to a series of presses, because at this point there is too much fluid in the material. It's too watery to make paper. So it goes into these rotary presses, which you can sort of just think of as a roller in the kitchen that you roll dough out with, and you simply squeeze out the water. It's very much the same kind of technology used to make orange juice. And now you can see this material, which is sort of a very thick mush coming out of the press.

And the liquid which was pressed out has to be treated because the liquid that was pressed out contains many of the ingredients of the tobacco

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf
Source: https://www.industrydocuments.ucsf.edu/docs/skhd0001

material. This contains certainly nicotine and other water-soluble materials which the manufacturers want to preserve and -- and keep in the process. So this is the material that goes to make the paper. So we have two streams now, the mush, if you will, and what I'll call the extract; that is, the juice that was squeezed out.

Think of it as making orange juice. When you make orange juice, you have the pulp that's left, and that you go make the paper with.

And then the juice comes out -- I'll call it the extract -- and that's going to come back into the process in a little while.

So here we have a material that's going to be made into the paper, and then here is the extract; this is the material that was squeezed out. It would be like the orange juice. But here what's happening to it -- very much like orange juice -- it's being concentrated. When you buy orange juice, frozen orange juice in a can, you're really buying a frozen orange juice concentrate as opposed to when you buy the large bottles where they haven't concentrated it.

So this concentration is done by evaporating off some of the water, and this is the -- this black liquor material is the -- is the extract which will

be added back to the paper later on.

Now this is the paper machine, and as you can see, it's a -- it's a sizable piece of equipment, probably a hundred feet down to the other end. And in this machine, that pulped material is spread out onto a moving belt, it goes through a dryer which dries it, and then what you're looking at here is a -- it's called a Yankee dryer, it's this very large rotating drum, and it turns. And right here is where the paper is being peeled off the drum, like you peel the skin off of an onion. So by the time this wet material moves through the dryers and dries and goes up over this drum, which is also sucking water and vapor out, it now has become a paper. And there's a little knife that cuts the paper and separates it from this drum. And now you have your paper made.

Now you have to put on the additives on this -- on this paper, and so next to the paper-making machine is a room which has a large number -- in this case -- of tanks of the various additives and chemicals that will be put on the paper. Now one of the things that will be put back on the paper is this concentrated extract. Another thing here is a dispersant, which allows the material to spread. Another additive here is DAP, which is an ammonia

compound, diammonium phosphate, which is added to the

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

extract material before it's put back on -- on the paper. And these are metered, they're carefully measured.

The -- the amount of material to be added, in this case the diammonium phosphate, is mixed with the extract in the mixing tank, and then from this mixing tank the material is taken over to the paper machine where we'll see it added onto the paper.

So these are all the pipes bringing the various chemical additives into the final mix tank. Other additives include urea, which is an ammonium compound, Jono, which is crushed -- which is St. John's Bread, it's a flavorant, and N10, which low-fat cocoa, and isosweet, which is a sugar. So these are all fed from separate tanks.

Now you go back out to the paper-making machine and you'll notice up here how it looks very wet and here it looks very dry. So this is -- where the arrow is is the dried paper that was just made, and it's now right -- over in this region the paper is going to be submerged in this additive material where you're taking the extract and adding it back and you're adding the sugar and the ammonium compounds. And up here it's wet, so it goes into a dryer and

that dries this material onto the paper. So they're coating it now with these chemicals.

Sometimes -- in the picture it looks like the paper is actually moving in the opposite direction it is, but you can see it's moving up into the dryer.

And right there is where the paper is coming off the Yankee dryer. So this is where the paper is being scraped off the dryer. It runs through some rollers and then it goes into the coating area. And you can see how fast that's -- how fast that's moving.

So it's now coming toward us, and then right below us -- we'll look down -- and there you see, right in here, you'll see the liquid that's being pumped from the room that had all the tanks, and basically the paper is being submerged in this liquid. You can see it's just being flooded with this -- with -- with liquid, the paper is being wetted, being coated with this.

And this is a -- basically a fluid-type coat operation where you're putting much, much more into this trough and running the paper through the trough. And the paper is actually moving from right to left. And that's the wet material, the additive, the extract, the ammonia compounds, the sugar and the

flavorants.

And there you can see -- right here you'll see the excess fluid running out of the coating bath, and it's returned to the room that had the tanks -- there it goes into a pipe. That will be pumped back to the room that had the tanks and then be pumped back out

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

to the paper-coating machine again. So this liquid is just running in a continuous circle. And some of it is -- is left behind on the -- on the paper.

Now it comes out of the dryer. So what we're seeing here is the paper coming out of the dryer and it has the coating on it now, so this is the coated paper reconstituted sheet. And there's a series of cutters that cut it up. The cutters were over here. And then it's --

The cut material, the cut paper is taken up this conveyor belt. It's going to be put into this rotating drum. And this rotating drum adjusts the moisture of the material, and then once that's done, it's going to be shipped off for packaging and then taken into the cigarette-manufacturing facility.

So there's the rotating drum. Here's the cut material going essentially through that wall and into the next room. So this is the paper recon, which is completed, and it goes into one of these essentially

huge trash compactors again. It's about two stories high. And you can see it falling through the glass there.

It's conveyed over. It's allowed to fall down into one of these containers, and then a ram -- actually what happens, it's kind of interesting, this whole cylinder fills up, and then a ram just pushes it all the way down and compacts it into the ram barrel, which puts the top on it, and moves another barrel in to prepare it for being loaded. So this big hydraulic ram will come down, it will envelop the container, it will clamp onto it, then the recon paper will come into this big vessel, it will fill, and then the ram will push it down. And these will be taken to the cigarette-manufacturing facility.

So now what we've seen is the band cast recon has ended up in these packages that go to the cigarette-making plant, and the paper reconstituted tobacco that has been made on another operation, it's going to the cigarette-making plant.

So now we'll go to the cigarette-making plant. So at the cigarette-making plant, what you see are all the various blends that are coming in. You can see them being moved across this -- this conveyor belt here. And remember, what you'll find in the

cigarette-making plant, then, is you'll find band cast recon, if they're using it, you'll find paper recon, if they're using it, you'll find bales of oriental tobacco, you'll find boxes or what are sometimes called hog's heads of burley and Maryland and Virginia or flue-cured tobacco. So these are all now coming together into the plant, and these have to be blended according to very, very strict specifications.

Now some of these are stored until they're used in large rows, much like library books, using these

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

automated fork lifts. And these automated fork lifts move up and down these rows either putting the various kinds of tobaccos in certain places or removing them as needed.

Now as a blend recipe is being followed in a plant, you have to take all these different kinds of materials which are compacted into these boxes and get them ready for the assembly, so what you see here as sort of like little soldiers marching in line are the various kinds of tobaccos and reconstituted materials that are awaiting inclusion into now the master blending process.

These all carry a bar code on them so the computers know exactly what's coming and when, and

the manufacturers can, you know, ascertain that the right material went into the right place.

And you can see that you have different -- different-looking kinds of material representing the various kinds of ingredients that are going to go into the blend.

So the boxes have been removed and these are lined up. Generally you have to -- these are compacted so tightly they have to be delaminated, and sometimes they'll put steam probes in to loosen the material. But this is completely automated. And once these are delaminated, and some -- sometimes they are cased, they are now put into blending -- blending silos as they're called. Because you'll see we're bringing in a burley or we're bringing in a -- an Oriental or some recon, and the way they're blended is the material, once it's been conditioned and moisturized and delaminated, is dropped into these very, very large containers from an overhead moving assembly which lays down essentially corn rows, it looks to me; goes back and forth and back and forth laying down the various materials. And at the very end of that is a huge rake. Once it's full, then you can mix it up and mix the blend together.

So there is the burley top casing. So what --

what you saw -- what you're seeing here is the burley tobacco, which is being taken into the casing cylinder and being top cased with sugar and licorice and so forth.

Now here you see a blend, it looks like some blend -- some recon coming in at the top and dumping down onto another line of material. So the blending operation, it's called the dry blending operation as you start bringing these various streams together.

And now this is a cutter, which is now cutting it down to a much smaller size, as you can see, dumping it onto another conveyor belt.

Now you see even more blending going on. You'll see the material coming from the left, material coming from the right. This is all, of course, prescribed by the formulation. And finally you have

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf
Source: http://industrydocuments.ucsf.edu/docs/skhd0001

your flavor cylinder at the very end of the line which puts the final flavor on. You can see there are many of them. But each -- each kind of cigarette will have generally a different flavor specification. And then that material is stored in these large bins, and it's now ready to go into the cigarette manufacturing.

Now what you're looking at here is the filter-making process. This is how the filters for

the cigarettes are made. The material that goes into the filter enters the plant this these large bales, this is cellulose acetate, and it comes off as a ribbon. And you can see it coming off. It goes over a loop and down into the machine where it's basically formed into a cylinder by this machine that we're now going to look at.

You really can't see what's going on inside the machine, but that ribbon is being turned into a -- a little rod and a plasticizer is added.

And now here come the filters. Now these filters aren't cut to size yet, you can see they're pretty long, because they are cut a little bit -- they're cut a little -- a little bit later in the process. And as these filters are made, they're stored in these overhead bins where you see them moving around up here. Because if they -- if --

You have to remember now, this is a continuous process. Cigarettes are being made all the time, and so you're going to need filters all the time. And if the filter machine breaks or if they have to change a bale, they have to stop the machine. So this serves as a surge area to store already-made filters that you can draw on if the machine stops.

And you can see down over here, here's -- here's

at filter-making machine. There's one back here in the far right-hand side of the screen. And so they're just lined up one after another, obviously making -- there's enough filters to satisfy the demand of the cigarette-making machines. And you can see there's banks of them. They're about two deep, and I don't know how -- how many long there were, 10 or so.

Now this is a cigarette-making machine. What you're seeing here is the tobacco coming out of those large bins. That's the final tobacco that's been made. It's been cased, it's been flavored, it's been cut, and the whole blend is made. And they're making Marlboro Lights in this particular machine. And so this is going into the cigarette-making machine, coming from the blends -- from the silo, from the storage silo into this machine.

And again there's not a whole lot to be seen other than to know that the paper is being brought in, the tobacco is being put onto the paper, being formed into a rod. Up above here at the top what

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: https://industrydocuments.ucsf.edu/docs/skhd0001

you're seeing are the filters which were made in the machines we just saw. They've now been brought over to the cigarette-making machine because they need to be added to the rod.

You get a sense of the speed at -- at which these machines are working. And when the filter is added to the rod, then the laser puts the ventilation holes in them, if there are any ventilation holes to be added, and out come the finished cigarettes.

Now these machines are running on the order of ten thousand cigarettes per minute, eight to ten thousand cigarettes per minute. And in one plant I saw they had 72 of these machines.

And here you can see the cigarettes now are coming down. These are the finished cigarettes. They're coming down this hopper and they're going to be split into two streams and then split into one, two, three streams. This is seven cigarettes, six cigarettes, and seven cigarettes. Seven, six and seven give you 20. So this is how they divide the cigarettes up, put 20 into a pack. And these three streams here are actually going to be brought together to create the 20 cigarettes. It's going to be wrapped up in a -- in a piece of foil, held into place, and then go into the packaging machine.

So if you're making ten thousand cigarettes a minute, you're making about -- I guess it would be about 500 packs a minute if I did my -- you might want to check me on that, multiplication or division

correctly.

And here come the packs. Now they're not in the package yet, they've just been bundled together in packages of 20. And then what this machine is doing is putting the various wrappings on to delineate the package. In this case I believe it was Marlboro Light. And what you're seeing coming in is some of the material that forms the package. And there's the packs coming out, each one holding 20.

And there they go. Now they're scurrying all around. And they will be directed to a carton machine, and the carton will take an appropriate number of packs and package them into -- into cartons. So as you can see, this is a very-high-speed process. When you have a machine that's making eight to ten thousand cigarettes a minute and you're in a manufacturing facility that has 60 or 70 machines that are operating, you can see that you're making maybe three quarters of a million cigarettes a minute.

And here's a packaging machine. It's putting the cartons together. Then these cartons are put into boxes and then these boxes are taken to a warehousing operation and then sent off for distribution.

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

And this is just looking down at all the various cigarette machines. You can see how -- how large this facility is. Each one of those is a cigarette-making machine, each one with a capacity of -- the ones I saw at least were around eight to ten thousand cigarettes a minute.

Q. Thank you, doctor.

MR. CIRESI: Do you want to take a morning break there, Your Honor?

THE COURT: Why don't we take a short recess.

THE CLERK: Court stands in recess.

(Recess taken.)

THE CLERK: All rise. Court is again in session.

(Jury enters the courtroom.)

THE CLERK: Please be seated.

BY MR. CIRESI:

Q. Doctor, when you were describing the reconstituted tobacco which -- which can consist of either a band cast slurry or reconstituted paper, you were talking about the need for binding the band cast slurry and that diammonium phosphate was put on for that purpose. Is that correct?

A. Typically diammonium phosphate and ammonium

hydroxide are used to elicit this molecular glue effect.

Q. And with regard to the tobacco that's reconstituted paper, does that need that type of binding?

A. No. As you may recall in the -- in the video, the -- the paper was made and then it was dipped in the -- in the bath that contained the chemical additives, the ammonia compounds and the extracts. So in the paper process it doesn't -- it doesn't need the ammonium compounds to act as a binder; it's just simply added on on the surface.

Q. Now you described how certain chemicals are extracted, goes into the slurry, and then it's placed back on either the tobacco paper or the band cast; is that correct?

A. Well in the band cast, the slurry of the material contains the ammonium compounds and -- and the band cast product is just simply made. The paper process, you do create this extract that has to be added back, and that contains the water solubles, and that's to which they add these additional chemicals, the sugars and the ammonia compounds and the low-fat cocoa and so forth. That gets added back on on the paper process.

Q. Now I believe you said nicotine is extracted out and then it's placed back on?

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

A. Nicotine is in the extract because it's water soluble, and so it goes through the concentration process and then it's contained in what we call the extract to which these other chemicals are also added, then that -- all that is put back on -- on the paper.
Q. Is there any chemical significance to the fact that the nicotine is placed on the paper, on the cover of the paper, if you will?
A. Well when the raw material came in for that process, it was stems and broken leaf and tobacco material which contains the nicotine bound to the plant structure in the way it was made and transported in the -- in the plant, so now it's been -- it's been taken out of that structure, chemically removed, and then added back on top of -- on top of the paper, so it's no longer in that -- in that same physical environment, and the effect that that has is to make it easier to -- to release.
Q. What do you mean by "release?"
A. Well it's referred to as the nicotine transfer efficiency, which is the ability of -- or the capacity for the nicotine to leave the solid material

and be removed into the vapor phase when the cigarette is combusted.
Q. So when you're smoking, you're talking about going from the tobacco itself into the smoke itself?
A. Right. And that -- the efficiency of that process is -- is enhanced by having physically relocated the nicotine on -- on the material, taking it out of where it is in the cells and then just basically physically absorbing it to the -- to the material. So it's in a -- it's in a position to be removed more easily, is a way to look at it.
Q. Doctor, I'd like to direct your attention now to some design parameters of the cigarette. From your review of the documents, did you learn of the term "compensation?"
A. Yes, I saw it referred to in the documents.
Q. Now from a design standpoint only, I want to direct your attention to that.
Did the defendants take into account compensation in designing their cigarettes?
A. Yes, they did.
Q. Can you direct your attention, please, to Exhibit 10299, which is in volume one. This is a Philip Morris document, it's a presentation entitled "Smoker Psychology Research" by Dr. Wakeham,

presented to the Philip Morris board of directors on November 26th, 1969.
Is this one of the documents that you reviewed during the course of your investigation?
A. Yes, it is.
Q. Does it form, in part, the basis of your opinions that you have and will render in this case?

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://tobaccodocuments.ucsf.edu/docs/skhd0001

A. It does.
MR. CIRESI: Your Honor, we would offer Exhibit 10299.
MR. BERNICK: No objection, Your Honor.
THE COURT: Court will receive 10299.
BY MR. CIRESI:
Q. We have the title page up, "Smoker Psychology Research" by Dr. Wakeham, presented to the Philip Morris board of directors, November 26th, 1969.
Could you direct your attention, doctor, to the page which has the number at the top seven, and it has the Bates number, last three, 748. In this part of the presentation does Dr. Wakeham address the issue of compensation to the Philip Morris board of directors?
A. Yes, he does.
Q. And can you describe what is being stated here by Dr. Wakeham?

A. He's apparently showing some slides, and in or around slide ten he said, "This great variability among smokers results from the fact that a smoker tends to seek his own level of intake. Even while smoking a single cigarette, he adjusts the volume of his puff as he goes down the rod, compensating for the change in the density of the available smoke."
Q. Now what's the significance of that, if anything, from the standpoint of the design of the cigarette?
A. From a standpoint of a drug-delivery device design, as we discussed yesterday, typically the control of the delivery of the drug is put into the hands of the manufacturer, and it's preset, if you will, at the factory. What distinguishes a cigarette is that that control is put into the hands of the consumer, and so the consumer, by adjusting the way in which the device is -- is used, can modulate, moderate, or adjust the nicotine that's going to be delivered to their body.
Q. Is that referenced at that portion of page seven of Exhibit 10299, next to the notation "Slide 12?"
A. Yes. Down toward the bottom of the page, if you look at number -- number three in particular, it says, "A smoker's intake level is determined by the

smoker himself, not by the manufacturer of the cigarettes." In this case, not by the manufacturer of the drug-delivery device.
Q. Doctor, can you direct your attention, then, to Exhibit 11275, still in volume one. This is a BATCo Ltd. document dated 12-9-84?
A. Yes.
Q. And it's entitled "R&D VIEWS ON POTENTIAL MARKETING OPPORTUNITIES?"
A. That's right.
Q. Is this one of the documents that you reviewed?
A. Yes, it is.

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

Q. And does the document form, in part, the basis for your opinions?
A. It does.
Q. And are the subject matters addressed herein also addressed by other documents of the defendants that you reviewed during the course of your investigation?
A. Yes, that's correct.
MR. CIRESI: Your Honor, we'd offer Exhibit 11275.
MR. BERNICK: No objection, Your Honor.
THE COURT: Court will receive 11275.
BY MR. CIRESI:

Q. And can you direct your attention, first of all, to paragraph one under "HIGH PRIORITY." It says "A. HIGH PRIORITY," and then one.
A. Right.
Q. And does this document address the issue of design for allowing the cigarette smoker to take her or his own desired level?
A. Yes. They're talking about the design of a -- of a product, and as one of the high priorities is the design of products that, as they call it, are elastic or compensatable. And it says in the document that, "Irrespective of the -- Irrespective of the ethics involved, we should develop alternative designs, paren, that do not invite obvious criticism, close paren, which will allow the smoker to obtain a significant -- to obtain significant enhanced deliveries should he so wish."
Q. And -- I'm sorry, go ahead, doctor.
A. I was simply going to say I interpret that as design attributes are being considered that will engender this built-in ability for the device to be controlled by the user any way that they see fit.
Q. And in paragraph two of this document, are nicotine deliveries the subject of what should be research and development by B.A.T?

A. Yes. That's the second high-priority item entitled "Nicotine Deliveries."
Q. And what is the significance of that portion with respect to the issues that you're here to testify to, doctor?
A. Well it recognizes that -- first of all, that nicotine is the key pharmacological component of cigarettes, that that is in fact the paramount issue in terms of the design to accomplish a nicotine-delivery device, and they're searching for or -- or directing attention to the need -- "have a greater understanding of the role in nicotine in the context of smoking" in terms of its irritation, in terms of its impact, arousal and satisfaction. They point out that the need perhaps to use animal research, as they say, "albeit in the medical departments or contract research establishments," and

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

asking the question whether or not smokers smoke for the transient peak effects, which would be the rise and fall of the concentration of -- of nicotine as it's taken into the body versus the build-up of -- of nicotine levels in the blood in the body as the day goes on and the smoker smokes.

And then turning the page, they point out -- and this is with respect to nicotine deliveries -- that

another area of importance is the exploitation of both physical and chemical means, any way that can be done, either by means -- a means to increase nicotine transfer, that is, to increase the effective utilization of nicotine, meaning to have a very efficient way of removing the nicotine from the reservoir and delivering it to the recipient.

Q. Did your review of the documents reflect whether or not the defendants did research the ways to effectively increase the utilization of nicotine and its transfer?

A. Yeah, there was extensive research aimed at that, yes.

Q. Can you direct your attention, doctor, to Exhibit 13250, which is in volume two. This is a document dated June 28th, 1985 directed to Mr. E. E. Kohnhorst, executive vice-president of B&W, carbon copy to Mr. T. E. Sandefur, S-a-n-d-e-f-u-r, who was the president of Brown & Williamson, and it's from R. A. Sanford, S-a-n-f-o-r-d, who was vice-president for research and development. Subject, "Research Program Future Products."

Is this one of the documents that you reviewed in the course of your investigation?

A. Yes, it is.

Q. Does this document form part of the basis of your opinion that you are rendering in this case?

A. It does.

Q. And is the document consistent with respect to the subject matter it addresses in documents of other of the defendants that you reviewed in this case?

A. Yes.

MR. CIRESI: Your Honor, we would offer Exhibit 13250.

MR. BERNICK: No objection, Your Honor.

THE COURT: Court will receive 13250.

BY MR. CIRESI:

Q. At the top we see that this is a Brown & Williamson Tobacco Corporation Research, Development & Engineering internal correspondence, it's marked "CONFIDENTIAL" along the side, it's dated June 28th, 1985.

With regard to future research projects, does this document address the issue of design of the cigarette with regard to the issue of compensation?

A. Yes, it speaks to design and compensation.

Q. And can you direct our attention to where that

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

is?
A. Toward the bottom of the page, it's -- it's involved with a discussion of -- of innovative

products that might be developed in the next few years, and Dr. Sanford is -- is listing four areas in which he feels knowledge should be developed, and in one he refers to is compensation. He says "It exists; most smokers practice it, but we need to understand it better before advantage can be taken in the marketplace. Here, I believe designing to the subconscious is preferred to requiring the smoker to commit a conscious act."
Q. And based on your review of the documents, what does that mean, designing to the subconscious rather than having a smoker make a conscious act?
A. It -- it might mean having a design element that could be altered or modulated during the act of smoking, but without the smoker really knowing they've done it because they're only responding to the desire they have for particular intake of the drug substance as opposed to consciously doing something to the device to change the way in which it operates.
Q. Does the cigarette from a design standpoint, and with regard to nicotine, allow for that type of -- in its design, allow for that type of subconscious action by the user?
A. Yes, certainly.

MR. BERNICK: I have an objection to form.
THE COURT: Okay.
MR. BERNICK: Can we have some specificity to exactly what's being referred to?
THE COURT: Could you rephrase that, counsel?
BY MR. CIRESI:
Q. What design parameters address this issue in the cigarette, doctor?
A. Oh, one that comes to mind is, for instance, the ventilation holes. On many, many brands of cigarettes the ventilation holes are not visible, and people who don't know that they're there could cover them up by the way they hold the cigarette or the way they place the cigarette in their mouth and therefore alter the manner in which the drug is delivered, versus having the ventilation holes opened, as an example.
Q. Now did your review of the defendants' documents reflect whether or not the defendants established a general control over the nicotine that was delivered in cigarettes?
MR. BERNICK: Objection, leading, Your Honor.
THE COURT: It is leading, counsel.

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

BY MR. CIRESI:
Q. Did the defendants research ways to control nicotine?
A. The defendants, in the documents that I reviewed, spent considerable effort in searching for ways to control nicotine delivery in cigarettes. No question about that.
Q. And can you direct your attention, please, to Exhibit 13431, which would be in volume two of the documents in front of you.
This document is entitled "PROCEEDINGS OF THE SMOKING BEHAVIOR MARKETING CONFERENCE," July 9th through 12th, 1984, and it's marked "CONFIDENTIAL," and it's a B&W document.
Is this one of the documents that you've reviewed with respect to the testimony you're giving in this case?
A. Yes, it is.
Q. Does this document form part of the basis of your opinions?
A. It does.
Q. With respect to the documents that you reviewed in this case from the other defendants, is it consistent with respect to the subject matters that are addressed therein?

A. Yes.
MR. CIRESI: We would offer, Your Honor, Exhibit 13431.
MR. BERNICK: No objection.
THE COURT: Court will receive 13431.
BY MR. CIRESI:
Q. Title page is up, "PROCEEDINGS OF THE SMOKING BEHAVIOR MARKETING CONFERENCE, June 9th to 12th, 1984, SESSION III."
First of all, doctor, can you describe just generally what this document is about?
A. Well apparently there was a -- a conference held over these three or four days in 1984. What this particular exhibit is is the -- is referring to session three at that -- at that conference, and what it focuses on in part is nicotine and the control of nicotine in smoking.
Q. Can you direct your attention, please, to the paragraph -- or I'm sorry -- to the page which has the last three Bates numbers 312.
A. 312?
Q. Yes.
A. Yeah.
Q. And at paragraph five of that page is the issue of nicotine addressed?

A. Yes.
Q. And what is set forth therein, sir?
A. Well they're discussing compensation and they're

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

discussing what it is that leads to compensation. They say that "Consumers may have been obtaining 14 to 16 milligrams of PMWNF" -- that means Particulate Matter, Water and Nicotine Free, that's another word for tar -- "(a normal equivalent nicotine delivery) for a very long time, compensating down to 16 milligrams when cigarettes deliver 25 milligrams and compensating up if they are now smoking a 13 milligram," as if they're seeking some kind of a level. "The discussion was biased on examples using PMWNF but it is accepted that nicotine is both the driving force and the signal (as impact) for compensation in human smoking behavior."

Q. And if you go back to the previous page, then, from a design standpoint, does it reflect whether or not B&W was taking compensation into account in designing products?

MR. BERNICK: Your Honor, again I object as leading. And there's no foundation.

THE COURT: It is leading.

BY MR. CIRESI:

Q. Just direct your attention to paragraph two on

page eleven, and specifically the second paragraph. What is reported there?

A. They're talking about designing products which aid smoker compensation. What they say is that "Compensation by modifying the smoking regime (b)" -- which refers to (b) above, puffing/inhalation, increasing or decreasing the puff volume, duration, puff frequency and amount, these are all things in the control of the smoker. "Compensation by modifying smoking regime is a topic which is being explored at GR & DC" -- now this is a research laboratory -- "and this includes designing products which aid smoker compensation." So it's clearly stated that in the design process and in the design thinking, compensation is one of the attributes that the designers wish to confer on this drug-delivery device.

Q. Can you direct your attention, please, doctor, to the page which bears the last three numbers 333. And what is set forth on this page?

A. This looks like an agenda of something referred to as the nicotine conference. It has seven sessions. First session is dealing with the nicotine dose requirement. And this goes back to what we were talking about yesterday with regard to this

dose-range window, what -- what -- what is it and where is it, because that's how you need to design the device. You need to have some sense of where that is. The nicotine dose estimation. Sensory and psycological effects of nicotine. Session on the effects of nicotine, interaction with the brain, pharmacology. The effects of nicotine, this time interaction with peripheral tissues or physiology.

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

Product modification for maximal nicotine effects. This would speak to design issues. And then a general session.

So you can see that this conference is heavily devoted and focused to nicotine all the way from dose to the effect and to the manner in which the product could be modified in terms of design.

Q. And can you direct your attention, then, to the next page with regard to session one. Does this give an overview of session one of this conference that was held in 1984?

A. Yes. Each of these sessions had -- has an objective. This is the session on nicotine dose requirement. The objective is "To examine evidence that supports the hypothesis that smokers smoke for nicotine based on market trends, smoky behavior and the tar-to-nicotine ratio of products."

Then it goes on to summarize, "Smoky behavior measures support oversmoking of reduced delivery products."

Number two, "Plasma nicotine and cotinine," which is a degradation product, an oxidation product of nicotine that happens in the body's metabolism, "Plasma nicotine and cotinine measures indicate 'maintenance' of nicotine intake.

"0.7 milligram nicotine products and above provide satisfaction" -- so this says something about the level at which the product might be set for delivery -- and "smokers require 12 to 14 milligrams of nicotine daily." So this would be a daily dose regimen.

Then they talk about developing a product matrix to specifically identify the role of nicotine.

Q. And can you direct your attention, then, to the next page, which is session two, "NICOTINE DOSE ESTIMATION," and describe what that session was about in 1984.

A. Here the objective was "To review the current status of plasma/urinary measures estimates of nicotine dose and to identify the significance for the smoker and" now "product design." So the product design is going to reflect to some extent the ability

to understand the relationship between the dose and the levels of nicotine in the blood or in the urine.

And the subheadings on this, "Under appropriate conditions plasma nicotine and cotinine measures can be used to estimate the daily nicotine intake." So they're basically affirming that a measure of the delivery that occurred to the recipient can be established by either -- by -- by plasma nicotine levels; that is, the nicotine levels in your blood.

"Findings suggest many smokers smoke to a 'constant' intake of nicotine."

And "Is this cause and effect; can it be resolved using a suitable product matrix."

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

And "Specific tissue concentrations may be more important determinants: how can they be determined."

So they're asking the question: Perhaps we might even get a -- a better measure in -- in some sense if we measure the tissue levels rather than blood levels, which they also have affirmed can be used to measure the daily nicotine intake.

Q. Can you direct your attention, then, to the next page, which was session three, "SENSORY AND PSYCOLOGICAL EFFECTS OF NICOTINE."

A. Well here they're identifying what they call the full range of the sensory properties of nicotine and

asking the question: How well are we equipped to assess them? And how is smoking used as a psycological tool by the smoker?

Q. And under the summary, number two, what's being referred to there, doctor?

A. Well they're referring to what's called the "pH dependent effect of nicotine," the "product matrix and manipulation may provide suitable clues pH." What they're referring to there is that nicotine occurs in different forms depending on the level of the acidity or basicity, or the -- or the pH.

Remember the pH scale went from zero to 14 and seven was in the middle or the neutral, wasn't acid or base, and so they're basically referring to the fact that they understand and recognize that the form of nicotine depends on pH, and they're inquiring as to how they might manipulate the matrix, the product matrix in order to exploit what they're examining.

Q. And can you then turn to the next session, session four, which dealt with "EFFECTS OF NICOTINE - INTERACTION WITH THE BRAIN (PHARMACOLOGY)." What was the subject matter of that session, doctor?

A. Well they're looking into the interaction of nicotine with the body, in particular the mechanisms

by which nicotine interacts with the body, and these are at the molecular level, and they want to relate that to not only the smoking behavior and smoking prevalence but to the whole body and tissue concentrations of nicotine. So here is an objective which is trying to relate all the way from smoking behavior to levels in the body to interactions at the mechanistic level in terms of the effect that nicotine has. So this takes you all the way down to the receptor level as in number one, the receptors that bind with -- with nicotine.

Q. And can you direct your attention, then, to the next page, which dealt with session five, and could you please describe the objective there and what the summary of that session was.

A. Well here they're asking a question --

Previous question was how -- the mechanistic effects of nicotine with certain basic receptors, and

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

here they're asking how does nicotine interact with peripheral tissues. Here the focus, as you can see, is on the respiratory tract as well as the whole body, and asking the questions if we -- about that mode of interaction and its significance for not only the product acceptability but the so-called smoker satisfaction or acceptance.

Q. And in the summary, do they reference product development?
A. Well number three, they're talking about investigating the fundamental nature of the upper respiratory tract nerve pathways and reflexes. Because as we talked yesterday, when the smoke is brought into your -- into your body, into your mouth and into your throat, there are sensations. And we had the Pavlov's dogs as an example yesterday of these sensations triggering, if you will, an association of the reward that is to come, and many of these triggering sensations occur in the upper respiratory tract which is enervated and does have nerves in it that can interact with -- with nicotine. And they're trying to understand if they can take what they can learn from those kind of interactions and apply them to product improvement and even novel product development, so exploiting that physiologic response.
Q. And finally, doctor, in this document, can you turn to session six, which dealt with "PRODUCT MODIFICATION FOR MAXIMAL NICOTINE EFFECTS" and describe what was the object of that session of this 1984 conference at B&W.
A. Well they want to maximize nicotine effects,

that's the -- that's the -- the objective in this, and what that -- what that points to is trying to make more effectual, if you will, the presence of nicotine, sort of extract the most out of it in terms of the whole-body effect it might -- that in fact results. And so they talk about, for instance, increasing their activity to develop non-combustible products, the possible ultimate test in our understanding of the role of nicotine, because this would be something that would essentially just be a nicotine-delivery device in some -- in some form.
But what it speaks to, as this entire document speaks to, is this -- this tremendous focus that the industry has on -- on their product and -- and trying to deal with it in such a way as to continually improve and make more efficacous its delivery to the recipient.
Q. And in number one, do they address current products?
A. Well they say "Sufficient is known to begin to improve the quality" -- now "sufficient is known" means sufficient is known about some of the effects, the nicotine effects -- "is known to begin to improve

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

the quality and characteristics of current products in terms of sensory and whole body effects based on

nicotine modification."
Q. Doctor, can you now direct your attention to an RJR document, Exhibit 13222, which is in the same volume.
Have you found that, doctor?
A. Yes.
Q. Is this a document that you reviewed during the course of your investigation?
A. Yes, it is.
Q. And it is --
Is it one of the documents that forms part of the basis of your opinion?
A. Yes.
Q. And is this document also consistent with what you generally found in the documents of the defendants in this case?
A. It is.
MR. CIRESI: Your Honor, we would offer Exhibit 13222.
MR. BERNICK: No objection, Your Honor.
THE COURT: Court will receive 13222.
BY MR. CIRESI:
Q. The title page states "RJR/Biosource Genetics, Joint Research Agreement." And what was this document, doctor?

A. Biosource Genetics was -- appears to have been an outside contractor that RJR had a collaborative arrangement with to develop strains, if you will, of tobacco products that would be genetically -- plants that would be genetically modified, and by genetically modifying these plants they could then control, for instance, the levels at which nicotine might be produced in the plant, as an example.
Q. Did other of the defendants research that issue?
A. Yes. Other of the research --
Other research was done by other defendants in this area of genetic -- genetic manipulation of the tobacco plant for the -- for the purpose of enhancing nicotine production.
Q. And can you direct your attention to page 8093 of this document. And does that address the issue you just described?
A. Yes. You'll see at the -- at the --
They're talking about the applications for the -- for the GENEWARE system, and the GENEWARE system is a -- is -- basically refers to a means -- a means whereby one can alter the genetic makeup of an organism, cause it to behave in a way that at least evolutionarily it had -- had not been doing in the natural sense. And here they're talking about

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf
Source: https://www.industrydocuments.ucsf.edu/docs/skhd0001

production of either high or low nicotine tobaccos; in other words, influencing the plant at the level of its genomic information to alter the way in which it either synthesizes nicotine to high levels or -- or low levels.

And they talk about the elimination of nornicotine. Nornicotine is a relative of nicotine, and the presumption here is that part of the metabolic energy of a plant goes into the making of nornicotine, and if you could eliminate that part of the metabolic pathway, then the energy that it was expending in making that might better be used in making more nicotine in the plant as a sort of a common way of thinking about genetic manipulations, and that is what's called redirecting metabolic synthesis or metabolic engineering in the organism itself.

Q. And the last bullet point here is "Improvement of Physical Characteristics, Processing Enhancements - Expansion, comma, Shatter." What is that referring to, doctor?

A. Well I think it's referring to perhaps building into the plant a more robust character so that the lamina doesn't shatter when it's being processed, because when it does, you end up with small

particles, and then that will probably end up in the recon rather than into the -- into the tobacco lamina part of the plant.

And the same is true, there's some forms of these -- of these tobacco materials that are difficult to expand because they tend to basically shatter when they're -- when it goes through this freeze/thaw cycle. So I would view this as a physical enhancement of -- of the material through some kind of a genetic means.

Q. Doctor, can you now direct your attention to Exhibit 18182, which is another RJR document. This document is dated February 5th, 1950 -- excuse me, February 5th, 1980, subject, "Winston B Nicotine Control." It's from Mr. H. E. Guess and it's directed to Mr. McKenzie, capital M-c capital K-e-n-z-i-e.

Was this one of the documents that you reviewed in the course of your investigation?

A. Yes, it is.

Q. Does this document form part of basis of your opinion in this case?

A. Yes.

Q. And is the document consistent with respect to the general subject matter that it is discussing that

you found in other defendants' documents?

A. Yes.

MR. CIRESI: Your Honor, we would offer Exhibit 18182.

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

MR. BERNICK: No objection.
THE COURT: Court will receive 18182.
BY MR. CIRESI:
Q. Doctor, in this memorandum, does the author address the issue of the dose threshold in the cigarette?
A. Well he does to the extent that he -- he talks --
They're talking about Winston B, which was a cigarette that was ultimately launched by RJR, and speaking about nicotine control in this cigarette. And one of the issues having to do with nicotine control, of course, is the nicotine that's in the crop -- crop blends, because that's where the nicotine comes from. And he's talking in the last paragraph, "A nicotine control system with upper and lower limits is one way to address this question," referring to the nicotine content in the -- in the grades that will be used in making the cigarette. They wanted to bracket that, so clearly that's where the beginning of the nicotine control is to get the

nicotine in the final product at the right -- in the right amounts so that when the cigarette is smoked, you land in the proper dose range.
Q. Did the other defendants, based on your review of the documents, address the issue of crop variations which would cause variations in nicotine?
A. Sure. This was an area of concern, and for all the manufacturers, because after all they are dealing with a natural -- a natural product, and depending upon dry years and wet years, the amount of nicotine, for instance, in these products can -- can vary, and so the manufacturing process has to be flexible enough to be able to deal with these kinds of natural variations in -- in nicotine. And then as you -- as you deal with those and you bring it into the plant to meet the manufacturing specifications, you have to be able to modulate and control the nicotine all the way through the plant so that finally when it comes out in the cigarette, you know what you have. It has to be made to those specifications.
Q. Doctor, can you direct your attention now to Exhibit 12505, which is about seven months after this document, and it relates also to the Winston B cigarette. And that's in volume one.
MR. CIRESI: This document is in evidence,

Your Honor.
Q. Now Exhibit 12505 is one of the documents you reviewed in this litigation?
A. Yes, it is.
Q. And it also forms part of the basis of your opinion?
A. Yes.
Q. The title of this document is "Clarification of my 07/22/80 Memo on Nicotine Additive," date

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

September 8, 1980, it's from the director of research, Alan Rodgman, and it's to Dr. Roy E. Morse, who's a VP for research and development.

Would you direct your attention, please, to the first page -- or the second page of the exhibit. In this memoranda, does Dr. Rodgman address the issue of nicotine technology and the factors which may bear on that issue?

A. Yes. Again we see the focus that in this particular case RJR has on -- on nicotine. It comes out by first of all talking about tar delivery, and then the next issue being nicotine delivery, and then the tar-to-nicotine ratio, which really follows from -- from the -- from those two, and then the whole issue of nicotine satisfaction and the large number of variables that nicotine satisfaction

depends on, such as the puff count, how many puffs you take in a cigarette, the volume of these puffs, the tar-to-nicotine ratio itself, the total absolute amount of nicotine that you take in, how much nicotine there is in a puff, plus the free nicotine per puff. This is the -- this is the form of nicotine that's uncharged, the so-called free base nicotine. So it makes a distinction between total nicotine delivery, which would -- which would be the free base form, the uncharged form, or the charged form -- the two together would constitute nicotine delivery -- separates out from that the free nicotine per puff. Because the latter, in turn, is related to nicotine delivery per puff and smoke pH. The inference there is that the amount of free nicotine, that is, amount of the uncharged nicotine, is going to depend again on the acidity or basicity, which is which of these two forms do we have or how much of each.

Q. And doctor, in the paragraph right below the indented paragraph, does Dr. Rodgman set forth what the purpose of this memorandum is?

A. Well the memorandum was -- was basically summarized in what -- what they were trying to do in these graphs and tables that are -- that are

attached. RJR saw that in the mid- to late 1960s the Philip Morris Marlboro brand began to exhibit very large sales and started to take a significant portion of the -- of the market share, and the Marlboro brand continued to -- to do very, very well as the -- as the '60s closed and the '70s opened, and RJR was concerned about this and -- and was trying to understand what it was about the Marlboro cigarette that caused this to happen, because their leading brand, Winston, on the other hand, was not holding parity against Marlboro at that time, and it was losing ground.

So what they're talking about here is the way in which they made comparisons between the Marlboro and

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf
Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

the Winston in trying to bring Winston and its attributes closer to those of Marlboro, because Marlboro seemed to be doing and in fact was doing very well. So they are talking about the nicotine technology that Marlboro must have, and they focused on nicotine in comparing the two cigarettes, and how they could control the smoke parameters noted above in a., b., c. and d., either by blend formulation or denicotinization rather than addition or transposition of nicotine. Something had to be done in their minds to their blend in Winston to try and

achieve this parity with Marlboro, and the focus was on the nicotine delivery and the form in which nicotine was delivered.

Q. And is the form of the nicotine addressed in footnote a on this first page of this text of this memorandum?

A. Yes, it is. Basically what that says is that, first of all, nicotine in the plant, in the -- in the -- in the matrix, is primarily in what's called the bound or the salt form. This would be a charged form of the nicotine molecule. They point out that most of the nicotine in smoke is present as the salt or the bound form and a small fraction is present as free nicotine.

Now remember, the smoke consists of these little liquid droplets and the gas and vapor that surrounds them. The bound form or the salt form or the charged form of the nicotine -- they're all the same thing -- can only exist in a -- in a -- in a liquid or attached to a matrix of some sort, but it -- it can't exist in the vapor. This salt form is not vaporized. The only form of nicotine that can exist in the vapor or in the gas is the uncharged or the free base form, and it can exist both in the liquid and in the gas.

And they point out that the percent of free nicotine depends on the smoke pH, because as the pH goes up, as the environment in which the nicotine finds itself becomes less acidic, or saying it a different way, more basic, whereas the pH is increased, you will create more of the free nicotine from the bound nicotine. So the bound and the free nicotine are in a ratio to one another which is dependent upon the pH, and as the pH goes up, more of the bound nicotine or the salt form or the charged form becomes the free base form or the uncharged form, and as the pH goes down, the reverse happens.

Q. Can you draw that, doctor, with regard to the vapor or gas form and the particle form?

A. Sure.

Q. Please come down and do that.

Before you start, doctor, let me just for illustrative purposes mark this as Exhibit 25013.

A. The first thing I'll do is draw you the

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

nicotine -- droplet of nicotine molecule in what's either called its bound form, sometimes used, its salt form, its ionized form or its charged form. These all mean the same thing, but they're used interchangeably.

Stand back to make sure I've done that

correctly. There we go.

Okay. To put this in the salt form or the bound form at low values of the pH, in other words, more acidic, a hydrogen ion from the solution attaches itself to this nitrogen group. Now this nitrogen group, now that it has more than three atoms connected to it, it now has four, takes on a positive charge, and so this entire molecule takes on a positive charge. And where this came from was from the dissociation of water. So when water is in solution, there are some hydrogen ions and some what are called hydroxyl ions in association with water, and at the low pH, some of these will come and attach themselves to the molecule. So this gives the molecule a positive charge. And in this formit can't be vaporized, it has to stay either bound to a solid substrate or present in a liquid form.

So if it's in the droplet, for instance, it can't leave the droplet unless it changes to the free base form. And the free --

Q. Doctor, in smoke then, if it's in the bound form within the particle, you're saying it cannot leave that bound form or the particle of -- of liquid?

A. It can't leave the particle as the bound form. It has to shift to the free base form to be able

to -- to get into the -- into the vapor. So this is what we call bound, salt, ionized or charged.

If I take this hydrogen ion away, so now we're back down to -- probably bringing back your worst nightmares of chemistry -- high pH. You'll notice that -- make sure I've got it right. You'll notice that this hydrogen now is missing -- let me divide this so you can focus on -- on the two molecules. And so sometimes what we'll do is we'll just write this as saying that nicotine in its charged form is in equilibrium with nicotine in its uncharged form. So nicotine without the -- without the hydrogen ion attached to it is this bottom molecule, and when you attach the hydrogen, you get the top molecule, and what controls the relative amounts of this is the pH. So you'll move to the right as you raise pH and you move to the left as you lower pH. And so these are in balance, depending on the acidity or the basicity of the solution.

At about a pH of eight, you have about half and half, half free nicotine and half of the bound nicotine.

So the names that are given to this are either free nicotine, unbound nicotine, uncharged nicotine,

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

it's also referred to as free base nicotine.

Q. Doctor, the equilibrium that you talked about moving right to left depending upon the alkalinity or the acidity of the solution, is there any analogy there to when you were talking about the mothball in the corner, you were talking about diffusion and trying to get equilibrium? Was that a different concept?
A. Without getting too detailed, let me say it's a little different.
Q. Okay. That's complicated enough for me, doctor.
A. I have -- I have a feeling everybody is probably so hungry now they probably don't care what it is.
MR. CIRESI: We'll take a short break there, then, Your Honor?
THE COURT: Why don't -- why don't we go. We'll reconvene at 2:00 o'clock.
THE CLERK: Court stands in recess to reconvene at 2:00 o'clock.
(Recess taken.)

AFTERNOON SESSION.
THE CLERK: All rise. Court is again in session.
(Jury enters the courtroom.)
THE CLERK: Please be seated.
MR. CIRESI: Thank you, Your Honor.
MR. CIRESI: Good afternoon, ladies and gentlemen.
(Collective "Good afternoon.")
BY MR. CIRESI:
Q. Good afternoon, doctor. When we recessed, we were on Exhibit 12505.
THE COURT REPORTER: Mr. Ciresi, could you turn your microphone on, please.
Q. When we recessed, we were on Exhibit 12505.
MR. CIRESI: Thank you, Mr. Stirewalt.
Q. Can you turn to the second chart in that exhibit.
A. All right.
A. All right. I'm plugged in.
Q. Plugged in? All right.
A. Just had some coffee. I really am.
Q. Can you tell the court and the ladies and gentlemen of the jury what the second graph on that chart is depicting, doctor? It's a little difficult

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf
Source: https://www.industrydocuments.ucsf.edu/docs/skhd0001

to make out. And there's some writing or a legend to the right-hand side of the graph itself.
A. Yeah. I think if you just pull it back, Tara, I can explain.
These are two graphs on the same chart. What is -- what is plotted on the left-hand axis is free nicotine, and it's plotted in micrograms per puff.
Q. Are you referring to the graph at the bottom?
A. Yes, the graph at the bottom.
Q. Okay.
A. You can barely read out on the left-hand "free nicotine," and then that's in units of microgram per puff. So that would be the free nicotine delivered in a -- in a single puff of that particular cigarette. And plotted on the horizontal axis is years, from 1970, and the axis runs until 1981, and plotted on there is the free nicotine per puff for two cigarettes, the upper cigarette or the upper line is for Marlboro, Marlboro 85, and the bottom line is the Winston 85.
Q. What do you mean by "85?"
A. It has to do with the length of the cigarette.
Now I mentioned before lunch that RJR, the manufacturer of Winston, was concerned about the fact that Philip Morris, who was manufacturing Marlboro,

seemed to be getting -- Marlboro seemed to be increasing in sales at a -- at a rapid pace, and people at RJR were trying to figure out why that was happening. And so they -- they have plotted in this particular sets of papers various smoke parameters in order to try and compare the attributes of each of these two cigarettes, and what they noticed is that of the smoke parameters that they measured, which included the amount of nicotine delivered per cigarette and the tar delivered per cigarette and the tar-to-nicotine ratio, that in 19 -- 1970 they were essentially the same. So based on those three measures, it appeared that the two cigarettes in 1970 were the same in terms of nicotine delivery and tar delivery and the tar-to-nicotine ratio, yet Marlboro seemed to be doing better in the marketplace.
What this bottom plot shows is that one of the parameters that seems to distinguish one cigarette from the other was the amount of free nicotine delivered. The amount of free nicotine delivered by the Marlboro was higher, and you can see that on the axis with the Marlboro cigarette at about four point two or three micrograms per puff, and the Winston at about two micrograms per puff. So the presumption was that in some way the Marlboro configuration was

delivering more free nicotine; that is, even though it was delivering the same amount of nicotine, the two cigarettes were delivering the same amounts of nicotine, the form of the nicotine was different in the Marlboro in that more of it was of this free

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

base.
And over the years, over the decade of 1970 to 1979, these smoke parameters actually, both for the nicotine and tar deliveries and the tar-to-nicotine ratios, diverged, and the free nicotine stayed diverged, but by 1980 everything had converged. And so the thought was, well, in 1980 we now have a Winston and a Marlboro which are delivering the same amount of nicotine per cigarette, the same amount of tar per cigarette, the tar-to-nicotine ratio was the same and the free nicotine delivered was the same, so now we may be in a position to be competitive because these attributes have all now matched.
So this was a trace, if you will, over a 10-year span of how these variables changed and how by 1980 they converged.
Q. Doctor, I'd now like to direct your attention to an RJR internal document which goes back in time to 1973. This document we just looked at is 1980. Can you direct your attention to Exhibit 12464, which is

the document immediately preceding 12505 in your book.
This is a document dated December 4th, 1973, an interoffice memorandum from Frank G. Colby, a senior scientist, to R. A. Blevins, Jr., director, marketing and planning, subject, "CIGARETTE CONCEPT TO ASSURE RJR A LARGER SEGMENT OF THE YOUTH MARKET."
Is this one of the documents that you reviewed during the course of your investigation?
A. Yes, it is.
Q. Is it one of the documents that you have relied on in part for the basis of the opinions you're rendering in court?
A. Yes.
Q. And is the document with respect to the subject matter consistent with respect to other documents you reviewed during your investigation?
A. It is.
MR. CIRESI: Your Honor, we'd offer Exhibit 12464.
MR. BERNICK: No objection.
THE COURT: Court will receive 12464.
BY MR. CIRESI:
Q. The subject at the upper left-hand corner is "CIGARETTE CONCEPT TO ASSURE RJR A LARGER SEGMENT OF

THE YOUTH MARKET," date December 4th, 1973 to Mr. R. A. Blevins, Jr., director, marketing and planning, from Frank G. Colby.
In this document does Mr. Colby refer to the pH regulation of cigarettes?
A. Yes, he does refer to it.
Q. And if I could direct your attention to the bottom of the first page of the memorandum, and let me read part of it -- in fact I'll read that whole paragraph. "In my judgment, for public relations

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

reasons it would be impossible to go all the way back to the 1955 type cigarettes. As far as tar and nicotine in the smoke are concerned, I believe it should be possible to achieve the desired effect by going to a tar level of today's Pall Mall, paren, non-filter type, close paren, of about 29 milligrams of tar and 1.8 milligrams of nicotine. Still, with an old style filter, any desired additional nicotine 'kick' could be easily obtained through pH regulation."

Now first of all, doctor, when there's a reference to "all the way back to the 1955 type cigarettes," what's being referenced there?

A. Well I think these are these -- these are these cigarettes that were being sold in the -- in the mid-

'50s which were generally quite high -- high tar, high -- relatively high tar and high nicotine cigarettes, tar levels up in the thirties and nicotine deliveries of around 2.5 or 2.6 milligrams.

Q. And when he's referring then to "the desired additional nicotine 'kick' could be easily obtained through pH regulation," what is being referenced there?

A. Well what he's -- and this ties into the document that we just looked at. The notion here is is that if you have the form of the nicotine such that there is more of this free base nicotine, because free base nicotine is going to be in the -- in the form that transfers through biological membranes, and its concentrations when the pH is shifted will be higher, that there will be an ability to deliver this nicotine more rapidly or for a shorter period of time to develop more of a bolus in the lung capillaries which would be delivered. So it's a way of enhancing, if you will, the effect of nicotine by changing its form.

And when he's talking about the initial kick, he's basically talking about the physiologic result of having done that. And that, of course, keys in with what we saw in the previous plot that seemed to

indicate -- or did indicate that the Marlboro had a higher delivery of -- of free nicotine than did the Winston in 1970.

Q. And if you go back up to the section of the memorandum right under the word "Memorandum," in the second paragraph is there a reference there to Marlboro with regard to the up and coming new generation?

A. Well he says that it's -- it's established beyond a doubt that Philip Morris's Marlboro cigarette has a much stronger hold on the up and coming new generation of smokers than Winston or our other brands. So this is also reflecting what we saw in the previous document. And the notion here is that what's really the root cause of this difference

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

is the form in which the nicotine is being delivered as opposed to the amount.
Q. Can you direct your attention now, doctor, to Exhibit 10014, it's toward the front of the volume in front of you. This is a Lorillard memorandum marked "CONFIDENTIAL" dated June 16th, 1976, it's to Dr. A. W. Spears, who was senior vice-president of operations in research at the time, and later became CEO, from H. J. Minnemeyer, the director of research.
Is this one of the documents that you have

reviewed in this litigation?
A. Yes, it is.
Q. Is it one of the documents that forms part of the basis of your opinion in this litigation?
A. It is.
Q. Are the subject matters contained therein consistent with the subject matters that you reviewed in others of the defendants' documents?
A. Yes.
MR. CIRESI: Your Honor, we would offer Exhibit 10014.
MR. BERNICK: No objection, Your Honor.
THE COURT: Court will receive zero -- 10014.
BY MR. CIRESI:
Q. You see the date and the author and the addressee, and the subject is "Progress Report on Nicotine Augmentation Project."
Now first of all, in the first paragraph does Mr. Minnemeyer state what the problem is that's being addressed in this memorandum?
A. Yes. What they're discussing here is trying to come up with approaches or -- to a problem or a solution to a problem, and that is how do you deliver more nicotine in the smoke of low tar cigarettes.

And as I described yesterday, during this period of time in the mid-'70s the tar levels are dropping, and concurrent with that the nicotine levels are also dropping. And so now there's a concern, as we enter this era of low tar delivery, how can we prop up the nicotine so that it doesn't fall through the bottom of our dose-range threshold window. So they're thinking of ways to in fact counter that concomitant drop of nicotine, thinking of ways to bolster it up.
Q. And in the second paragraph does Mr. Minnemeyer set forth two general approaches, doctor, to that problem?
A. Yes, he does.
Q. Can you describe those, please.
A. Well one is to simply bring nicotine in and add it to the blend. This is called nicotine augmentation. So this is just pure and simple add more nicotine to a cigarette that's delivering -- that would have otherwise delivered low tar and low nicotine, they would raise it by adding more

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

nicotine. The other was to consider ways in which you could take the nicotine -- the nicotine you have available and somehow optimize its delivery to make it more available or enhance its availability to the user without having to add additional nicotine. So

these were the two approaches.
Q. If you could turn, then, to page two. In dealing with the first approach, adding or augmentation of nicotine, is there reflected in the second, third and fourth paragraphs approaches that were researched by Lorillard with regard to augmenting nicotine by adding nicotine?
A. Yes. They -- they simply talk about ways in which they might add nicotine, as I -- as I said earlier, to the cigarette blend as a means of bolstering up the nicotine. And I could go into that in some detail if you want.
Q. If you would, please.
A. Go through this.

So in the first one they point out that "Nicotine augmented cigarette samples prepared so far have been reported to be burley-like and strong, much stronger than was expected." The burley tobaccos, a smoke -- cigarette made almost entirely, let's say, out of burley, is difficult to smoke. It has intrinsically an alkaline smoke where it's just difficult to inhale, and there's a lot of irritation. It's much stronger than was expected, he said, these nicotine-augmented cigarettes. "It has been observed that the smoke pH of these cigarettes was higher than

control," and "the amount of the pH increase is proportionate to the quantity of added nicotine." And this is because nicotine itself is a base-like material; it will make something more basic than -- than otherwise just simply by being -- being present. And so it can -- it can contribute, if you will, to the overall pH.

So they said "Participants in this work now feel that a satisfactory low tar smoking article might be achieved by the addition of much less nicotine than was previously thought necessary. By spraying the blend with a small amount of nicotine it might be possible to get the impact of a higher tar and nicotine cigarette. This might be achieved without actually changing the tar and nicotine figures one would get from untreated tobacco."

So the thought there is maybe you don't really have to add all that much nicotine since it has the effect of raising the pH, and with that you're going to get more of the free base character and you might even not even have to add enough that anyone would be able to make a measurement of it because it -- it wouldn't have to change the tar and nicotine figures even though you did add nicotine to it. So that was one of the things that they were thinking about.

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

So "The recent conception that a small amount of supplemented nicotine might lead to a satisfactory low tar cigarette seems to be supported by another study completed recently. Whether correct or incorrect, it had been the impression of those personnel working directly on this project that competitive companies were adding nicotine to their products."

So the presumption at this time by Lorillard was that, based on what they saw happening in the marketplace and based upon their view of how they can combat the problem of going to the low tar cigarette and having nicotine drop through the bottom of the threshold window, is that other people might be adding nicotine, other companies might be adding nicotine to their products. At least that was the suspicion.

"If any significant amount of nicotine were being added, it would be reasonable to expect a change in the nicotine-to-tar ratio for those brands when data accumulated over a long time span is examined." So "Accordingly, these ratios were calculated from FTC" -- that's the Federal Trade Commission way of measuring nicotine and tar -- "these ratios were calculated from FTC and other data

for 19 leading brands of cigarettes, many over the period 1956 to 1976." But they did that, and "No instances could be found where the data could support the contention advanced above," that they were adding nicotine. "However, if small amounts of nicotine were added to any of these tobacco blends, this would not show up in these particular data."

So there was still in shadow of a doubt in their mind that there might be nicotine augmentation taking place elsewhere, but at levels that were going undetected by these measurement techniques. So this all speaks to this nicotine augmentation and considering it as a reality and thinking that perhaps your competitors are doing it.

Q. And in the next paragraph, then, are other approaches to adding nicotine referenced by Mr. Minnemeyer?

A. Well then he shifts gears here and takes the other approach, which is can we manipulate the form of the nicotine in order to enhance, as the -- as the term was used, its kick, and that would be done by doing something to the tobacco that would change its pH, and consequently the smoke pH, and as a consequence of that carrying more of this unprotonated or free base nicotine with it.

And they talk about spraying ammonium hydroxide.

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

Ammonium hydroxide is what results if you take ammonia gas and bubble it into water. Get a solution of ammonium hydroxide and they spray that on some tobacco and the tobacco turned green, so they abandoned that idea. Later they tried using just ammonia gas directly on the -- on the material, and they thought that that approach might have some merit and deserve further exploration.

So it goes on in the last paragraph and says "The approach which considers altering smoke pH to deliver more free nicotine without an adverse taste effect is active but still in the formulative stages. An outline for a critical report on smoke pH has been submitted by Dr. Chen. The report may serve as a basis for a research proposal which would have the objective of determining the optimum pH for Lorillard's products, and the parameters which determine the optimum pH."

So they basically make a -- a "go" decision here to explore the avenue of pH alteration as a means of enhancing the physiologic response to nicotine in smoke delivery to a human being.

Q. And doctor, can you turn to the next page, page three of Mr. Minnemeyer's report, and specifically

paragraph three. Is there referenced therein another design mechanism that can be utilized to increase pH?

A. Well one of the -- the effects that accompanied air dilution; that is, the -- either the -- particularly the ventilation where the holes are drilled into the filter of the cigarette, of course another way of achieving some air dilution is to use a very porous paper in the cigarette. It says, "It is known that air dilution increases the pH of smoke and increases the nicotine-to-tar ratio."

So the effect of ventilation seems to be twofold, one is that -- and you have to realize that when you -- when you ventilate a cigarette, you -- you -- you alter a lot of the variables that control the combustion process, because when you ventilate the cigarette you have excess air flowing in through the filter, the velocity of smoke in the rod slows down, you combust less material per puff, and it changes a number of parameters. But the outcome seems to have been that the pH of the smoke increased as did the nicotine-to-tar ratio. Well those would be two advantages to ventilation, because if the pH goes up, then the amount of the free base nicotine increases. That's something that they were looking at to try to enhance the, quote, kick of the

cigarette. And if the tar -- if the nicotine-to-tar ratio increases, that's something they also would like to see happen, because, as I said, as tar and nicotine were coming down and you hold the nicotine at a level and the tar keeps coming down, and -- and that's equivalent to saying that the nicotine-to-tar

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

ratio is going to be increasing.
Q. And at the same time, then, in 1976, does the memorandum reflect in the next paragraph whether or not Lorillard was looking at the optimum dose threshold level?
A. Well they state that "Efforts to determine how the physiological effect of nicotine might be heightened, or to determine the optimum or minimum amount of nicotine necessary to provide satisfaction has largely been centered on background reading." That would indicate that they, too, are aware that there is going to be some, shall I say, window in which nicotine delivery must -- must fall. And at least at this point in time they seem to have relied primarily on what they call background reading, some 50 papers they had read on the subject, but again points to this knowledge and understanding that such a window exists.
Q. And finally, doctor, on the last page of that

memorandum, is there a reference to the type of work that had been done in the pharmacologic -- or psychopharmacologic area?
A. Well they point out that they're gathering papers on the psychopharmacologic effect of nicotine and cigarettes in man, and that this area of research has attracted attention only in recent years, and relatively little has been published.
Q. Can you now direct your attention, doctor, to Exhibit 10101, which is another Lorillard document in the next year. It's dated April 18th, 1977, submitted by Paul D. Schickendantz, with a carbon copy to Dr. Minnemeyer, who wrote the previous memorandum. Bears the accession number 994 and it's marked "CONFIDENTIAL."
Is this one of the documents you've reviewed in order to prepare yourself to testify?
A. Yes, it is.
Q. Does it form part of the basis of your opinion?
A. Yes.
Q. And is the subject matter therein consistent with the subject matter of other documents that you have reviewed in this litigation?
A. It is.
MR. CIRESI: Your Honor, we'd offer Exhibit

10101.
MR. BERNICK: No objection, Your Honor.
THE COURT: Court will receive 10101.
BY MR. CIRESI:
Q. We have the face page up there which shows submitted by Mr. Schikendantz with a carbon copy at the bottom to Dr. Minnemeyer and to Dr. Marmor.
Can you turn to the first full page of text in the document. The subject is "Gas Phase Ammoniation of Tobacco." Now this is a year later. Is there a reference again to the issue of the lowering nicotine

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf
Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

levels in cigarettes?
A. The very first sentence states that "The trend toward low tar cigarettes necessitates that ways be found to maintain nicotine satisfaction for the smokers of these new brands," which is tantamount to saying that as the nicotine -- as the tar levels get down, one has to pay real close attention to where the nicotine levels are and make sure that they remain above this -- this threshold for pharmacologic activity.
Q. And does Mr. Schikendantz reference the fact that one design method had already proven of value to Lorillard?
A. He pointed out, as we just discussed, that

air-dilution filters, ventilated filters had helped in this way. As we saw, what it did was to raise the pH and it increased the nicotine-to-tar ratio.
Q. Now in the previous memo, Mr. -- or Dr. Minnemeyer had referenced two ways to go, one, augmentation of nicotine, two, changing the form of nicotine.
Does Mr. Schikendantz in this memo in the first paragraph make a choice as to which way to go for Lorillard?
A. Well he actually points out that the one method, air-dilution filters, had worked. He doesn't seem to mention nicotine augmentation, but he -- which was a -- which was mentioned before, but he -- he does discuss that addition of tobacco bases having a greater base strength than nicotine might be another approach. "Such a tobacco treatment might be useful if it resulted in either a greater efficiency of nicotine delivery or an increased smoke pH. An increased smoke pH would liberate nicotine free base from its salts," that is from the charged form, "to give a greater chest impact."
Q. And if we move into the next paragraph, doctor, does he give an explanation with respect to ammonia and what impact, if any, it might have with regard to

free nicotine?
A. Well he's talking about ammonia, to begin with, as imparting an off-taste to cigarettes, and he says the off-taste results from either too high a delivery of the unprotonated or free nicotine, the creation of products with off-taste from the reaction of tobacco sugars with ammonia, and residual free ammonia being delivered in the -- in the smoke. So this off-taste that ensues from the addition of ammonia, he points out, is -- results either from the addition -- the presence of the free base, and when ammonia is combusted in the cigarette combustion process and you have these chemicals that are being pyrolized or torn apart by the -- by the intense heat that's approaching them, when they recombine, they can recombine with some of the ammonia fragments or some

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

of the sugar fragments, and these give ammoniated materials that carry taste, and I think it's fair to say that some of them can probably carry a positive taste and some of them can carry a negative taste; that is, they can taste good or taste bad. And he's pointing out that there are those that result from these kinds of reactions that give an off-taste.
Q. And at the top of the next page, does he make reference to the amount of ammonia in relationship to

a smoke pH target?
A. It says, "An estimate of a reasonable level of ammonia to add can be determined," at least for a start, "from the optimum amount of free nicotine which might be acceptable in the smoke, an assumed pH target, and a known relationship between ammonia content and smoke pH."
So the question here is if you're going to add ammonia to the tobacco material or to some fraction of the tobacco material, where do you begin? And he's basically saying that think about the amount of free nicotine you might want to be generating and the pH that might do that, and if you have a relationship between ammonia content and smoke pH, you could use that in order to get started in this kind of an investigation.
Q. Now doctor, one of the other ways that you referenced earlier in your testimony to manipulate nicotine that was reflected in the defendants' documents was genetic engineering. Do you recall that testimony?
A. Yes.
Q. Can you direct your attention to Exhibit 13671, which would be in the second volume. This is a document dated April 7th -- excuse me. I'm at the

wrong place. Excuse me.
It's a B&W document which is entitled "Y1 PRODUCT," it has a "Confidential" stamp.
Is this one of the documents that you reviewed in preparing for your testimony here?
A. Yes, it is.
Q. And does this document form part of the basis of your opinion?
A. It does.
MR. CIRESI: Your Honor, we would offer Exhibit 13671.
MR. BERNICK: No objection, Your Honor.
THE COURT: Court will receive 13671.
BY MR. CIRESI:
Q. Now this is entitled "Y1 PRODUCT." Now based on your review of this document and others, can you describe what the Y1 product was, doctor?
A. I believe that B&W had a collaborative arrangement with a company on the outside that had the ability to make genetic manipulations in plant material, and in particular in the tobacco plant, and

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

that such genetic manipulations were in fact accomplished in order to create a tobacco plant strain whose genetic makeup had been altered so as to confer on it the capability of producing higher than

normal levels of nicotine in the plant material.
Q. And were products sold in the United States with that genetic material?
MR. BERNICK: Objection, lack of foundation.
THE COURT: Sustained.
Q. Based on your review of the documents, were cigarettes sold in the United States with this material?
MR. BERNICK: Same objection, Your Honor.
THE COURT: You may answer that.
A. I am aware that the Y1 product was contained in cigarettes sold in the United States.
Q. And can you describe what's being referenced here in this document, doctor?
A. What's being referenced here is a description of the Y1 product, its attributes, showing that the Y1 product has a nicotine content of about 6.5 percent, that would be by weight, whereas a conventional flue-cured tobacco would be about half that. So through genetic engineering they were able to develop a tobacco strain capable of synthesizing or manufacturing twice as much nicotine as it might otherwise have on a weight basis. And as a result, if you look at the tar-to-nicotine ratios in number

two and you compare lights, which is a characterization of cigarettes in the mid tar range, the tar-to-nicotine ratio for lights is 12 to 13 to one, 12 or 13 to one, in that range, whereas the lights made from Y1 has a tar-to-nicotine ratio of 10 or 11 to one. So the tar-to-nicotine ratio has dropped, indicating the increase in the nicotine in the Y1 tobacco.
And then likewise a comparison is made between ultra, which is the lowest characterization for tar deliveries, versus a Y1 ultra, and again you see the tar-to-nicotine ratio is lower, it's on the order of nine to 10 for the ultra, and 10 to 11 for ultra.
So this had its effect of lowering the tar-to-nicotine ratio; that is, bolstering up the -- the nicotine in the face of the lower -- of lower tar. And they point out that they're using about ten percent of this Y1 in the -- in the blend.
Q. And if you go to page two of that document, is there also a reference to development of alternative ammonia sources?
A. Since it's pretty clear that the industry is using ammonia in some form to alter the form itself of -- of the nicotine, it appears that they engaged in the possibility of looking for ways to produce

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

ammonia and putting it into the product different from what they were already doing, such as modifying the current ingredients to produce ammonia, that is to say, casings, or natural methods, that is fermentation, which would use organisms presumably that produce ammonia as part of their metabolic cycle.

Q. Doctor, if you could, I'd like you to step back to the drawing board and describe how the changing of the form of nicotine from protonated to unprotonated to free base enhances the delivery of nicotine.

A. Well let me begin by reminding you that when the smoke leaves the cigarette and enters the body, it consists of these -- in a general puff of well over a billion little droplets suspended in a gas phase, and it's -- and these little droplets are propelled with the gas phase as it moves into your mouth, and then it enters your lungs as you inhale and goes down the trachea, splits into all of these little branching forks until it reaches the deepest-most regions of your lung, the alveoli area where the gases are exchanged between this little cavity, the alveolus, and the capillary.

So what I want to do is take you down now into an alveolar structure where we have one of these

little drops and talk a little bit about how the pH, this shifting of the form of the free base, can be used to enhance the rate at which nicotine will be taken up into the capillary system, creating a bolus effect; that is, a high concentration of nicotine that will then be delivered to the receptors in the brain.

So I'm going to draw a portion of the -- this would be the capillary wall that separates the -- so I'm not drawing the whole thing. You can imagine a big round circle here, and I'll put -- this is where the blood is over here. And for illustrative purposes I'll draw an aerosol particle, just one. And you'll recall that the size of an aerosol particle is about the same size as the thickness of the wall, so if we're back in our three-hundred-foot room, the walls are about six inches or so thick, like a egg shell, and an aerosol particle would be roughly the size of, say, a softball. It would be a little larger. That gives you some idea of the scale.

Now contained in the aerosol particle are the two forms of nicotine, the free base form and the protonated or charged form, and the charged form is the one that has to live in the particle -- can't get

out -- but the free base form can.

Q. Why can't it get out?

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf
Source: https://www.industrydocuments.ucsf.edu/docs/skhd0001

A. It's in a salt form. You can't vaporize an ion under these conditions. It has to be in a neutral state. It would be like vaporizing sodium ions out of a salt solution, you know. Won't happen.

But now this nicotine that's free can leave, and the question is: Will it? And the answer is: Yes, if there's a driving force for it to leave. And the driving force is very much the same driving force I described to you yesterday; that is, if the concentration of the free base nicotine in here is higher than the effective concentration out in the vapor phase, it will leave and it will try to equilibrate. We say it will equilibrate until what we call the activities of the free base in the particle is the same as the activity out here in the vapor phase.

And for purposes of this discussion I'll just indicate -- we'll just call them concentrations. So I'm going to draw another set of arrows, and the arrows mean that this can bounce back and forth. It can -- this can shift to the left and it can shift to the right. And I'll come back to that. And now it can -- the free base can come out here to the gas

phase.

Now if this was just a cement wall, this alveolus, and I left this particle in here for a sufficient amount of time, this would equilibrate. The gas phase would fill up with some of the free base, and when this free base molecule leaves here, another one will be made, you see, to keep this in equilibrium. So this whole dynamic system is -- is trying to even itself out until it's stabilized, and then that eventually would happen.

Now the interesting thing is is that if I take a free base molecule out into the vapor phase, then this equilibrium will shift a little bit to the right to replace that one. Likewise, if I were to bring one in, it might move the equilibrium to the left because it's sensitive to the depletion or the addition of the free base.

Now I have the nicotine out here, and the thing is, this isn't -- this isn't a concrete chamber, it has walls that are permeable to this material, free base. And so this free base, in turn, can go through this wall, through this capillary wall into the blood. Now you can see that if it does that, then there will be a tendency for more free base to come out to replace the one that left and more of this to

shift over and make more free base.

Ultimately, again, if I were to wait a sufficient amount of time, you could imagine I could deplete this -- most of the nicotine that's going from here to here to here to the -- into the blood, into the left heart, and up the carotid arteries to the brain and throughout the body.

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf
Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

Now having said that, what drives this process and what does pH have to do -- have to do with it? Well let's just take a look at a simple relationship that allows us to interpret the rates of nicotine uptake, and I'll just write it down as sort of the amount of nicotine that's transferred across this wall per unit time. This is the rate. I'm asking: How fast is this process happening?

Well it's proportional to -- I'm just going to write this as a -- some constant which I'll call K. And K is like a resistance. It's sort of how hard is it going to be for the nicotine to get through this wall and end up in the blood. The larger the value of K, the harder it's going to be.

But what's driving this process? What's really driving this process is the concentration of nicotine in the alveolar space that's right here at this wall, ready to move through it, minus the concentration of

nicotine in the blood. And I can simply write it as this -- as this difference.

So if the concentration of the nicotine is -- is high here, and it will be lower here because the blood has a lower concentration of nicotine in it, just like the diffusion process I described to you yesterday of oxygen in the lungs, oxygen going from the lung into the blood because it's going downhill, it's going down a concentration gradient or a little slope in concentration, the nicotine will flow down that hill through this membrane and out to the other side.

So you can see that the amount of nicotine per -- per unit time that's passing through this membrane is very closely related to the concentration of nicotine that is going to be seen here on this side of the membrane. And we can take for our purposes here that this concentration in the blood is not changing very rapidly and, for the purposes of our discussion, is remaining fixed.

So now what controls this concentration? You can see that the higher this concentration, the larger this difference, the more nicotine per unit time.

Well let's ask that question: What controls it?

Well what controls the concentration right here at the membrane must somehow be related to the concentration of nicotine here. You would expect the higher it is out here, that this would follow, it would be high here. If it was low out here in the gas phase, it would be low here. If it's high here, it would have to be -- you would have more nicotine in the free base form here to make it high out here, and so forth.

So let's ask some questions about just how fast these processes are occurring.

If I extract a nicotine free base and put it out

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

in the vapor phase, the decomposition and reequilibration of this will occur on the order of microseconds. Very, very fast. So the real question is how long does it take the nicotine free base that's maybe sitting here in the center of this particle to get to the wall? In other words, how rapidly does the free base move around in here?

One can do a time scale analysis of how fast that is. I won't go through that, but it's on the order of milliseconds. So I'll write that down as milliseconds.

Q. What's a millisecond, doctor?

A. It's one thousandth of a second.

In other words, the distribution of the tree base nicotine, as well as the other materials in here, is moving around on a millisecond time scale; that is, to go from the center to the wall and back to the center. So when you see that arise in the time scale analysis, what it says is that the concentration of these species is pretty much uniform in here; in other words, the concentration of free base nicotine in the center isn't a lot higher than it is at the wall. It's very rapidly mixed. You can almost think of it as just being churned up.

Now when this free base nicotine, which now is uniformly spread throughout this drop, decides to leave, another one is converted, keeping this relatively the same, keeping this at the same concentration. It's always being shifted by this equilibrium. So the fact that I'm losing some, as long as I have some of this, doesn't necessarily -- it will not measurably change the amount of free base that I have here.

So now it's out here and you say, okay, here's a free base nicotine molecule out here in this 300-foot room. How -- what's its time scale? How long does it take it to go from the center of the room, if that's where it is, to the wall where it might be

able to go through and get into the blood? You do a time scale analysis for that. Turns out it's also milliseconds.

Now these are what we call order-of-magnitude analyses, but they give you a real good description of where the rates of a process are being controlled.

Now what this means is is this is a well-mixed compartment. The concentrations are remaining in equilibrium. And out here, this is also a well-mixed compartment. Whatever the free base concentration is out here, it's distributed essentially uniformly throughout the alveoli. Well that means that the concentration here at the wall, then, is effectively the concentration that's present in the alveoli itself because everything's moving around so fast.

Now the reason that this happens on a millisecond time scale in a much bigger space is

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

because this is moving around essentially in air, whereas this one is moving around in a -- in a liquid, and so this moves more slowly relative to this,. But because of the scales of these two, this one can move around -- the free base in the particle can move around and mix itself up just as effectively as the free base can out here in the alveolar space. So the concentration out here in the alveolar space

is essentially the same everywhere, and that sets the concentration here at the wall. That sets the speed.

Now let's back up. If the concentration here at the wall is effectively the concentration here in the vapor space, and this concentration is directly related to this concentration inside, then anything I do to manipulate the concentration of free base inside the drop will immediately be communicated to the wall. Because if I change this concentration, let's say I increase it, then within milliseconds that increase is felt. Within more milliseconds this goes up, that goes up, and the rate goes up.

You can almost think of it as if I had a little free base meter here, and if -- if the concentration of free base was rising, it would follow out here and -- and, of course, at the wall it would follow, up and down, up and down, the rate would go up and down, up and down. There is no lag. There's no lag in the system.

You can also show that the time that it takes the free base molecule to travel through this membrane is on the order of milliseconds. So these -- these are really very, very fast processes.

It's hard sometimes for us to imagine that because we don't live in a millisecond world, we live

in a world of seconds and minutes and hours. But to give you an idea, you might ask, well, how long does it take this particle, this droplet, to maybe reach this wall and maybe attach to it and unload some of the nicotine? What's the time scale for the movement of that particle? Well the time scale for the movement of this particle within the alveolar space is on the order of seconds. So seconds to milliseconds is like one year to a thousand years. So for all intents and purposes, all this is going on very, very rapidly, and relatively speaking this particle is -- is not really participating in the -- in the action other than being a reservoir for the free base nicotine, which is now going through the wall.

So what does pH have to do with this? If the pH of this particle is high, then the equilibrium would be shifted to the right. What happens? The concentration of the free base is elevated. That's elevated, that's elevated, the rate's elevated. I lower the pH, I shift more to the left, this concentration goes down, this concentration goes

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

down, that goes down, the rate goes down.
So this rate is inextricably coupled to the pH of this drop, its acidity or its basicity, and any

changes in it will change this rate.
Now what does that have to do with what happens in the blood? The analogy that I'll give you -- let's see if this works -- you know in airports they have those moving walks you can sometimes walk on? Let's imagine that at the end of this moving walkway is where the blood is flowing by. It's picking up anything that comes along this moving walkway. Okay? Make any sense? Now let's say I take some popcorn, if you will, we'll pretend that popcorn is the nicotine that's -- that's going across, and let's say that I have a low pH. So I have a low pH, I have a lower concentration of free base in the droplet which communicates to a low concentration of free base in the space and a low concentration here at the wall and a reduced number of nicotine molecules per time, so that's sort of like just sprinkling the popcorn slowly onto the moving belt as the moving belt goes -- goes by, marching through here. And so you, the recipient of the blood at the other end, just see it coming through, and it's spread out over a long time, and the concentration, the amount that's coming out at you, is relatively small.
On the other hand, if I have a high pH, it's

like I took all the popcorn and so I just dumped it into a pile and it all comes out at once at the other end and gets carried away in a bolus.
So what's happening here is by changing the rate of the nicotine crossing the capillary membranes, I can change the concentration in the blood of the nicotine that reaches the brain. And as Dr. Hurt told you, this is an important consequence in terms of the pharmacologic effects that nicotine has in that it's concentration dependent.
Q. Thank you, doctor.
A. I think that pretty much completes it.
THE COURT: Let's take a short recess at this time.
THE CLERK: Court stands in recess.
(Recess taken.)
THE CLERK: Court is again in session.
(Jury enters the courtroom.)
THE CLERK: Please be seated.
MR. CIRESI: Your Honor, we would offer Exhibit 25014 for illustrative purposes. It is the diagram that Dr. Robertson just testified to.
MR. BERNICK: No objection, Your Honor.
THE COURT: Court will receive 25014 for illustrative purposes.

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf
Source: http://www.tobaccoindustrydocuments.ucsf.edu/docs/skhd0001

BY MR. CIRESI:
Q. Doctor, could you direct your attention in volume one of your book to Exhibit 10110. This is already in evidence. It is a document dated July 12th, 1976 written by Leighton Chen. It's a Lorillard document. And if you could direct your attention to page ten of that research memo which is entitled "pH OF SMOKE, A REVIEW."

MR. BERNICK: I don't think that's in evidence.

MR. CIRESI: Is it not in evidence? I think 10101 is in evidence. Let me -- let me lay the foundation, Your Honor.

BY MR. CIRESI:
Q. Doctor, please go back to the first page. This is 10110. It's dated July 12th, 1976, submitted by Leighton Chen, it's entitled "PH OF SMOKE, A REVIEW," and it's from the Lorillard Research Center in Greensboro, carbon copies are directed to, among others, Dr. Minnemeyer and Dr. Ihrig.

Have you seen this document before and have you reviewed it?
A. Yes, I have.
Q. And is it one of the documents that forms the basis of your opinions in this case?

A. Yes, it is. Yes, it is.
Q. And are the subject matters therein that are covered consistent with the documents that you reviewed of other defendants?
A. Yes.

MR. CIRESI: Your Honor, we'd offer Exhibit 10110.

MR. BERNICK: No objection.

THE COURT: Court will receive 10110.

BY MR. CIRESI:
Q. Do you see there the title page, Lorillard Research Center, Greensboro, "PH OF SMOKE, A REVIEW," submitted by Leighton Chen, July 12th, 1976, and at the bottom you will see the addressees who received carbon copies.

If you could direct your attention to page ten. Now there's a graph there -- if you could bring that up a little bit. Thank you. We've seen this graph -- at least the ladies and gentlemen of the jury have seen this graph during the course of the trial, and it deals with unprotonated, monoprotonated and diprotonated nicotine.

Can you describe, doctor, what's going on in that chart? It is a little busy.
A. It would be helpful if I could actually point to

the screen, or do you want me to try to do it sitting?
Q. Well I don't know how you could point to the

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf
Source: http://www.tobaccoindustrydocuments.ucsf.edu/docs/skhd0001

screen.
A. With my arm.
Q. Oh, that --
(Laughter.)
Q. I guess you --
Use your arm, doctor.
THE COURT: Isn't the computer world wonderful?
(Laughter.)
A. Okay. Up here on the left we have the nicotine molecule which is diprotonated. You can see there's a hydrogen ion there, there's a hydrogen ion right here. So it has two plus charges. And if the pH of the solution is very low, that species forms almost 100 percent of the possible three species of nicotine, the monoprotonated and the non-protonated.
So this curve represents the fractional amount of the diprotonated, this curve represents the fractional amount of the monoprotonated, so as the pH goes up, the amount of the monoprotonated begins to increase and the amount of the diprotonated begins to decrease, and so you go like this.

So by the time I get to about a pH of six, the predominant species is the monoprotonated species, and as I keep increasing the pH, the monoprotonated species begins to decline and the amount of free base begins to increase. So the message is that as I move along the pH scale, the relative amounts of these three forms of nicotine changes as well. So you can imagine marching along here and I get less and less of the diprotonated, more and more of the monoprotonated, until it's almost predominantly the monoprotonated; then as I move along I get less and less of the monoprotonated and more and more of the -- of the free base. So the -- what this chart is trying to communicate is -- is that taking place as pH changes.
Q. Now doctor, this is a rough scale. Is there unprotonated as we move down the horizontal scale, the pH scale, from six to four to two, is there unprotonated in -- at those levels also?
A. There would be -- there would be --
MR. BERNICK: Objection to the form. It's leading.
THE COURT: Well you may answer that.
A. There will be some unprotonated, not very much, as you move to these lower pH's, because the

prominent -- the prominent species will be the di -- the diprotonated. But there's never zero of anything; there will always be some species present.
Q. And the nicotine equilibrium that you just drew for the jury and the court which was on Exhibit 25014, does that nicotine equilibrium take place along the pH scale?
MR. BERNICK: Objection, that's leading.

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://www.tobaccodocuments.ucsf.edu/docs/skhd0001

THE COURT: It is leading, counsel.
Q. At what point does it take place along the scale?
A. Well it -- it takes place in principal at all points along the scale, but that particular equilibrium is most relevant in the range where you have mostly the monoprotonated and the unprotonated species. The concentration of the diprotonated species at the -- at the pH's that we're talking about, which are, say, from five or so on up, the amount of -- of this diprotonated species is really deminimus. It, too, can't evaporate. It's stuck in these particles to the extent that there is some diprotonated material there.
But this process that I described operates on a continuum. As you shift the -- as you shift the pH back and forth, the level of the free base rises and

falls inside the particle, and the level of the free base in the gas phase rises and falls and sets the rate at which the nicotine will be delivered across the capillary membrane into the blood.
Q. And that takes place along the pH scale.
A. Yes, takes place. And you can -- you can almost imagine that as you -- as you move from a lower pH to a higher pH, that the -- that the free base concentration that's present in the alveoli just rising as the pH rises, and concomitantly the rate is also increased. And as the pH drops, then the rate slows down. And this -- the fact that it's all in equilibrium so instant -- at -- in the millisecond time scale relative to the time scale of inhalation or the time scale of a particle to move about is really controlled by those processes.
Q. Now does ammoniation increase the pH?
A. Well ammoniation will increase pH, you know, all things held constant. If you ammoniate, it will increase.
Q. Can you direct your attention, doctor, to Exhibit 13155.
Can you change the pH in ways other than ammoniation?
A. Yes, you can.

Q. Exhibit 13155, which is in evidence, is an RJR document prepared by Mr. Teague -- Dr. Teague, and if you could turn, please --
The title, first of all, is "IMPLICATIONS AND ACTIVITIES ARISING FROM CORRELATION OF SMOKE PH WITH NICOTINE IMPACT, OTHER SMOKE QUALITIES, AND CIGARETTE SALES."
Could you direct your attention, first, doctor, to page four of this document, and specifically to paragraph Roman numeral VII, "RESEARCH ACTIVITIES, CURRENT AND PLANNED." First of all, is there a reference here by Dr. Teague as to whether or not the information contained herein was described to RJR

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

management?
MR. BERNICK: Object to the form of the question, it's leading. Also assumes facts not in evidence.
THE COURT: You may answer that.
A. Well the first sentence says, "As its part in -- As its part in this collaborative effort, Research" -- and that's capitalized, meaning a research organization -- "has: (1) collected, correlated, interpreted and described to Management data on smoke pH of various brands." So it has been reported to management.

Q. And is there a reference that information with regard to the methods of measuring of pH have been developed?
A. Well in the second paragraph -- or I'm sorry, in the -- number two in that same sentence says "developed and put into routine use improved methods for measurement of smoke pH."
Q. And in this paragraph of this exhibit, is there reference to RJR's following and surveillance, if you may, of the Marlboro brand?
MR. BERNICK: Your Honor, I object. All these questions are leading questions. Document's before the witness.
THE COURT: Okay. That question is leading.
BY MR. CIRESI:
Q. What does this document reflect with respect to Marlboro, if anything, doctor?
A. Well they refer directly to Marlboro under number three where they say -- where they said "Research has: discovered and reproduced the additives and procedures necessary to prepare the G-7 type of material used to increase the smoke pH of Marlboro."
Q. What's the G-7 type of material, based on your

review of the defendants' documents?
A. That's reconstituted paper type sheet that is produced by RJR.
Q. Please continue then, doctor.
A. Then it says, four, referring again -- you asked me about Marlboro, "monitored, on a continuous basis, smoke pH and related properties of Marlboro," then it goes on to say, "other Philip Morris brands, Kool," their own brands, and then some competitive brands. So Research is actively following the smoke pH of not only its competitive brands and its own brands, because -- realizing that this is now become really a key parameter in the -- in this cigarette design process.
Q. Doctor, let me read to you from paragraph -- or number four of the first paragraph, "evaluating various methods whereby smoke pH may be increased, with emphasis on ammonia treatments of stem

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

materials."
Now did your review of the defendants' documents reflect whether or not they were researching ways to increase pH through the use of ammonia?
A. Yes. There's extensive research conducted to ascertain how ammoniation of -- of -- of the constituents of tobacco could be done and how it

could be used to effectively alter the form of nicotine in the product.
Q. And did your review of the defendants' documents indicate other methods that may be used to increase smoke pH and/or nicotine kick?
MR. BERNICK: Again, objection to form, it's leading.
THE COURT: You may answer that.
A. Yes. There's a number of ways in which smoke pH can be altered. They're enumerated in this last paragraph where it reads, "Methods which may be used to increase smoke pH and/or nicotine 'kick'" -- so it's considered to be equivalent -- "include increasing the amount of (strong) burley in the blend" -- the burley tobacco is known as a more alkaline tobacco, it -- it has a higher pH, so if you add more of that into the blend than some of the other materials that are more acidic, like the flue-cured, you can use that as a means of modulating the smoke pH -- or two, you can reduce the casing sugar used on the burley and/or the blend. So if you've used sugar in your burley casing or in -- say in a casing that might have been put on the flue-cured portion, if you reduce the sugar, then during the combustion process, since the sugars tend

to form acids in the pyrolysis process which tends to -- would tend to lower the pH, you reduce the sugars and then that won't happen and you won't have that effect of lowering the pH due to these additional acids in the smoke. Or you can use alkaline additives, and this -- it says here usually ammonia compounds. So this would include the diammonium phosphate or the ammonium hydroxide or the urea, which is an ammonium compound, or you could use, and has been used, ammonia gas. All of these will act in such a way as to tend to cause an increase in the -- in the pH.
Q. Doctor, could you then direct your attention to that part of Exhibit 13155 which bears the Bates numbers at the end 4141. It's an August 10th, 1973 letter -- or memorandum, I should say, to Mr. Blevens from Jerry Moore, marketing research department.
A. Okay, I have it.
Q. It's entitled "CORRELATION OF PH AND SHARE OF MARKET PERFORMANCE."
Can you describe what's being related there, please.
A. In this short memo they're describing the

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

results of examining the extent to which the market share of certain brands relates to the pH, and they found that, as they state, "In the analysis of differences and performance between WINSTON and Marlboro and between SALEM and Kool, pH does correlate equally well -- equally as well with performance as does free nicotine."

Now the total nicotine in Winston and Marlboro and in Salem and Kool is almost equal, meaning that the potential delivery of nicotine is similar, yet differences in share of market seem to be related to the pH.

Now they go on to say that "Since pH is a measure of the percent of free nicotine and since the amount of free nicotine present would then depend on the total amount of nicotine, two brands with the same pH could have different amounts of total nicotine and, therefore, different amounts of free nicotine."

And basically what they're saying there, if something has a different amount of -- of total nicotine but has the same pH, you will -- you will still have proportionately more free base and -- and therefore different amounts of free nicotine in those -- those two particular -- those two particular brands.

Q. Can you direct your attention, then, doctor, to

Bates number 3228, which is an August 14th, 1973 memorandum to Mr. William D. Hobbs, who's the president of RJR, from Mr. Sandefur --

A. What was that number again?

Q. 3228. The same exhibit number, doctor.

A. Oh.

Q. It's just another page of the same exhibit. I'm sorry. Still on 13155.

A. Yeah, I'm still on that one, but the Bates numbers are out of order, so I'm --

Q. They are. We had to reconstruct this document. It was taken apart.

A. So which Bates number are we looking for? Oh, 3228?

Q. Correct.

A. Okay. Got it.

Q. This has marked at the upper right-hand side of it "SECRET." And it's entitled "Tobacco Development Product Direction."

A. Right.

Q. And is there a reference here to research regarding acceptable levels of pH?

A. Yes, there is. In the second paragraph it says, "As agreed, this research program should also answer the question on the maximum acceptable level of pH

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

that optimizes tobacco satisfaction. Marketing believes that this testing program should be developed between Tobacco Development and Research and coordinated through Marketing Research by them." And they'd like to keep -- be kept informed.

So that's the question that they've set out, what is the, in this particular case, the maximum acceptable level of pH that would tend to optimize.

Q. And I think I may have misspoke. I think that Mr. Sandefur at this time was the president of RJR and became the CEO of Brown & Williamson. It was directed to Mr. Hobbs, who was the president at that time of RJR.

MR. BERNICK: Your Honor, I object to the statement by counsel. I don't think there's a proper foundation for that.

MR. CIRESI: Well, Your Honor, we'd have to read in all of the interrogatory answers as foundation for that if we had to put in every single name and who they were. We had to ask questions as to who those people were. That's why I said that.

MR. BERNICK: Your Honor, I object to the statement by counsel. We can certainly figure out who these people are, but I don't think the statement that was made was correct. I'm simply making the

point that that is not a correct statement.

I also would note that there was reference made to these documents being reassembled. I believe the document came in in its proper original form, and as part of an effort to get cleaner copies we agreed to have the second document come in.

MR. CIRESI: We put this document together, Your Honor.

MR. BERNICK: Well you may have put the document together --

THE COURT: All right, counsel. You may continue.

BY MR. CIRESI:

Q. Can you go to the top of that document, and in faint letters I think you'll see that there were also copies that went to Dr. Senkus, who was the head of R&D, and Mr. Teague.

A. That's correct.

Q. Can you direct your attention now, doctor, to Exhibit 13141. This is an RJR document from the early 1980s.

Is this one of the documents that you've reviewed in order to prepare to testify?

A. Yes, it is.

Q. Is it one of the documents that you relied on to

form part of the basis of your opinion?

A. Yes, it is.

MR. CIRESI: Your Honor, we'd offer Exhibit 13141.

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf
Source: https://www.industrydocuments.ucsf.edu/docs/skhd0001

MR. BERNICK: No objection, Your Honor.
THE COURT: Court will receive 13141.
BY MR. CIRESI:
Q. Doctor, at the top it says the title of this in regard to technology is "Ammoniation." Can you tell us what's being referred to in this document?
A. Well it begins with a definition of what ammoniation is, and then there's a background section which tracks the use of ammoniation in the industry as it relates to Philip Morris and RJR. It's sort of a chronological assimilation of events, and it ends with a bullet point listing of product characteristics that are inherent with materials that have been ammoniated.
Q. And does it reflect when Philip Morris began using ammoniated sheet tobacco?
A. It indicates that Philip Morris began using an ammoniated sheet material in 1965.
Q. And it states, "This time period corresponds to the dramatic sales increase Philip Morris made from 1965 to 1974." With regard to that statement, did

you review any documents in this case which related to that issue?
A. Yes, I did.
Q. And what did you find from your review of the documents?
A. The -- the indication was is that at -- a time period in the mid-'60s when Philip Morris began ammoniating their sheet material and including it into their cigarette production was coincident with the time that the Marlboro brand began to grow very rapidly. This was noticed by -- certainly by RJR and others of the members of the industry who -- who then -- who then essentially began reverse engineering the Marlboro product to find out what had happened. And slowly but surely evolved the conclusion that ammonia technology was the secret to the success of Marlboro. And once that had been realized in the industry, essentially everybody began research and development efforts aimed at assessing the means whereby ammonia technology could be incorporated into their products as well. And this was followed in 1974 by RJR including ammoniated products in -- in Camel.
Q. Is that referenced in this document?
A. Oh, yes, it is. "RJR introduced ammonia --

ammoniated sheet material in the Camel filter product in 1974."
This in turn was followed by -- actually The American Tobacco Company started using ammoniation also in the late '60s, I believe around 1967, followed by RJR in 1974, followed by Brown & Williamson in the 1980s, and also by Lorillard in the 1980s, around the 1986-'87 timeframe as I recall. So slowing but surely everyone fell in line, and

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf
Source: https://www.industrydocuments.ucsf.edu/docs/skhd0001

ultimately many of the brand products across those companies included ammoniated products in them.
Q. If you direct your attention, then, to the second page, does it describe product characteristics that accompany ammoniated products?
A. The product characteristics that are listed here that are associated with ammoniated products include a milder, smoother taste. I've seen documents that indicated that many people felt that this was associated with part of the Marlboro popularity. A higher smoke pH. That's a result of the ammoniation. More chocolate-burley type. Positive flavor without negative burley characteristics. It doesn't have that -- the burley flavor which, if it gets too strong, it becomes difficult to smoke. A cleaner taste with, as we've seen now, more free nicotine.

And we've seen that related to the, quote, the kick. A stronger physiologic impact with less harshness. And differing flavor effects depending upon the type of tobacco ammoniated.
Q. Doctor, can you turn, then, to Exhibit 12800, which is another RJR document. This is a document authored by two chemist Ph.D.'s, E. Bernasek, B-e-r-n-a-s-e-k, and C. W. Nystrom, N-y-s-t-r-o-m, directed to Dr. G. R. DiMarco, who was the vice-president, research and development, and date of this is August 9th, 1952 -- excuse me, '82. I'm sorry.
Is this one of the documents that you've reviewed, doctor?
A. Yes, it is.
Q. And has it formed part of the basis for your opinion?
A. It has.
Q. And have you found it consistent with documents of other defendants that you reviewed concerning this subject matter?
A. Yes, I have.
MR. CIRESI: Your Honor, we'd offer Exhibit 12800.
MR. BERNICK: No objection, Your Honor.

THE COURT: Court will receive 12800.
BY MR. CIRESI:
Q. On the first page, the two chemists report to Dr. DiMarco that "Attached are position papers describing the rationale for using certain additives in RJR Tobacco flavor formulations." One of those is ammonia. And I'd like to direct your attention to the ammonia comments in this document, doctor. If you could direct your attention to the third page which bears the Bates number -- I guess the fourth page, including title page -- 8509.
At that point is there a discussion with respect to the ammoniation of reconstituted tobacco?
A. Yes. There's a heading entitled "Ammoniation of

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

Reconstituted Tobacco."
Q. And can you describe what's reported in that section, doctor.
A. Well there's a historical note to begin with. This, as we've just seen, is an RJR document in the 1982 timeframe, so they're looking back -- saying that they had begun studies on ammoniation of reconstituted tobacco back in 1973 as a result of R&D studies carried out during the 1950s and the early -- and early 1970. During the 1950s it's Dr. Teague, who we've encountered already in several documents,

"investigated the ammoniation of tobacco and tobacco stems and reported dramatic improvements in the smoking qualities of ammoniated tobacco stems. Smoke harshness and irritation were reduced and taste properties were improved." They go on to talk about what happened in the early 1970s. A major -- a major R&D program was initiated to investigate the physical chemistry of tobacco and tobacco smoke in an attempt to gain a better understanding of the factors affecting smoke harshness, irritation and strength, and from these studies they were able to conclude that the pH of cigarette smoke is important to smoke quality, and it can be -- I believe it's "useful" -- or it can be used as a measure of physiological strength of smoke. So it's important to both the smoke quality and some measure of the physiological strength.

Points out that ammonia in smoke is one of the major pH controlling factors, because ammonia can alter the pH. But there are other base materials and acid materials in smoke that can also affect the pH, and these include nicotine itself, amines, which are other organic compounds that contain nitrogen and tend to be basic, organic acids, which tend to be acidic, and also carbon dioxide, which tends to make

a solution acidic.
Q. And if you turn to the next page, then, doctor, is there a reference with respect to the marketing of RJR products with ammoniated technology?
A. Well there's an indication that --

First of all, it reviews the fact that Philip Morris introduced ammonia in their cigarettes in 1965, that they use this diammonium hydrogen phosphate or diammonium -- DAP as it's called -- in their reconstituted tobacco process to liberate ammonium pectinate prior to casting the recon -- reconstituted tobacco sheet. And what they were using was this -- this slurry process that we saw earlier in the -- in the film where you have very fine particles and you incorporate the ammonia into the slurry and use that as -- so as to help generate a molecular glue. And they point out, having done that, Philip Morris brands, especially the Marlboro brand, began growing in sales very rapidly after the

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

introduction of added ammonia, and correlation studies relating increased smoke pH, which followed from the ammoniation, to sales trends showed a very strong positive correlation.

So this was the -- the indicator that led RJR and then others to focus on ammonia, which in some

documents, as I indicated earlier, has been referred to as the secret -- the secret of Marlboro.

Q. And if you direct your attention to paragraph seven, it's related to "Smoking panel results showed a decrease in smoke irritation and harshness and an increase in physiological satisfaction with increasing ammonia content."

Now first of all, what's a smoking panel, based on your review of the defendants' documents?

A. My understanding is that when new -- when changes are made to a cigarette formulation or a new type of cigarette that is being designed, they will -- the industry, the companies will make small batches of these new materials and they will have panels or groups of people who will smoke these cigarettes. And typically, at least in the examples I've seen, these people are given ballots or they're asked questions about the cigarette. They'll be asked questions about harshness and impact or strength or satisfaction or taste or mildness, but very subjective questions as to how that cigarette seemed to them. And then that information will be gathered together and will go back to essentially the product designer who then takes in that information and, presumably, if it looks like something can be

done to respond to the panel's findings, they'll make additional changes. And presumably they'll go through another panel until they believe that they have a formulation that might merit some consumer acceptance. I think at that stage, typically, they go to a larger group of people, ultimately to a test market, maybe a city or two in the United States, again gathering information before they actually launch a product. So it goes through a series of steps in the development process.

Q. And when it's referring to "physiological satisfaction with increasing ammonia content," what's meant by the "physiological satisfaction," doctor?

A. That would be the pharmacological effect.

Q. And in the next paragraph it's reported, "Based on the above observations, it was decided to investigate the use of ammoniated reconstituted tobacco (G7A) as a means of increasing the smoke pH of RJRT's cigarette products. NFO tests indicate that smokers prefer products containing G7A" -- really can't make out the next line, but the last line says -- "the introduction in the CAMEL Filter in 1975," and then "G7A has been tested and/or introduced in nineteen additional brands."

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf
Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

Now let me ask you a question. When we put this together with the last document, did you learn when the ammoniated reconstituted tobacco was introduced in the Camel filter?

A. I believe that was 1974.

Q. And did your review of the documents indicate whether or not G7A had been introduced or tested in some 19 other additional brands of RJR?

A. Well there is --

I can't as I sit here verify the 19 additional brands, but that's approximately right. We have -- I have the -- the information as to when ammoniation began based on the formula documents I've seen in -- in all the brands that have been made by all the various companies.

Q. Doctor, could you then direct your attention to Exhibit 13069, which is the next exhibit in the book. This is a B&W exhibit dated 5-18-89, it has "CONFIDENTIAL" on it, comes from the Brown & Williamson library, research and development library, it's stamped "RESTRICTED" -- or typed "RESTRICTED," and it's entitled "AMMONIA TECHNOLOGY CONFERENCE MINUTES, LOUISVILLE, KENTUCKY, MAY 18th-19th, 1989," prepared by Dr. R. R Johnson. And there is a legend at the bottom, "THIS REPORT MUST NOT BE COPIED OR SHOWN TO UNAUTHORIZED PERSONS."

Is this one of the documents that you reviewed with respect to preparing to testify in this litigation?

A. Yes, it is.

Q. And does it form part of the basis of your opinions that you're giving in this litigation?

A. Yes.

Q. And with respect to the subject matters that are contained therein, does it address the same issues that were addressed by others of the defendants?

A. Yes.

MR. CIRESI: Your Honor, we'd offer Exhibit 13069.

MR. BERNICK: No objection.

THE COURT: Court will receive 13069.

BY MR. CIRESI:

Q. We have up there on the title page -- can you make it out? -- it says "AMMONIA TECHNOLOGY CONFERENCE MINUTES, LOUISVILLE, KENTUCKY, MAY 18th-19th, 1989."

Doctor, if you could, please, would you turn to the page which has the last Bates numbers 4016, and is this executive summary where the objectives of the conference set forth?

A. Yes, they're enumerated under headings one, two,

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

three and four. One is to "Share information about the importance and use of ammonia technology" -- which is abbreviated AT -- "worldwide.

"Determine opportunities to accelerate AT application.

"Define needed research to fill knowledge gaps."

And "Discuss areas of possible collaborative research."

Q. Is there a reference in the first paragraph with respect to ammonia technology used by other manufacturers?

A. Well they point out that ammonia technology is the key to competing in smoke quality with Philip Morris worldwide, again recognizing the use -- the use of ammonia technology by Philip Morris in 1965 and the associated and correlated success that that had with share of market and sales. They point out that all U.S. manufacturers except Liggett use some form of AT on some cigarette products. "Its widespread use of Philip Morris has led the consumer to associate AT with good tobacco taste."

Q. Can you direct your attention, then, to the next page, doctor. Under the "Current Usage of Ammonia in the Tobacco Industry," is there a reference with respect to the amount used?

A. Indicates that, at least in 1989, the industry was using about ten million pounds of ammonia compounds a year. That's equivalent to about five thousand tons of ammonia. And they point out that that corresponds to about ten milligrams of ammonia compounds per cigarette produced.

Q. And what does this research report state with regard to the main effects of ammonia technology on that page?

A. Indicates that the main effects are "Enhanced natural," which is underlined, "flavor/body via formation of volatile nitrogen flavorants," which I referred to earlier, "Improved nicotine transfer, Reduced irritation via scavenging of irritants and buffering," and "Superior paper recon," or -- that's reconstituted, both "(sensory and physical) by urea addition."

Q. And nicotine transfer, what does that refer to, doctor?

A. It refers to the removal of nicotine from the tobacco material into the smoke.

Q. And can you direct your attention, then, to page 4019, and specifically to the bottom of that page where it talks about the effects of ammonia on blends, casings and smoke chemistry.

Can you describe what's reported therein.

A. Well they -- they talk about a paper that was given by a Dr. Werner Hass entitled "Effects of Ammonia Distribution on Cigarette Blends," and summarizing the results says "Both ammonia and

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf
Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

nicotine transfer readily, ammonia faster," and "The direction of transfer depends on the molar imbalance." And on the next page, "RCB," which is a reconstituted sheet, "exhibits nicotine scavenging due to its enormous ammonia content."
Q. Well what's the term "nicotine scavenging?"
A. Well the way it's used here, it refers to the interchange of -- of nicotine in the tobacco product itself, as I understand it. You can -- if you have a constituent of the tobacco, say a reconstituted sheet that's in the tobacco itself, mixed in and blended in, but it has a high ammonia content, that ammonia will transfer to other parts of the blend and release and mobilize, if you will, nicotine which then can back-transfer to parts of the blend that are low in nicotine. So it allows for a mobilization of the nicotine within the blend itself.
Q. Doctor, can you now turn to Exhibit 13182. This is a confidential Brown & Williamson document with a routing slip to a number of individuals on the first

page. Its date is January 4th, 1980.
Have you reviewed this document preparatory to testifying in this case?
A. Yes, I have.
Q. Does it form part of the basis of the opinions that you are rendering in this case?
A. Yes.
Q. And does it address the issues that you found in others of the defendants' documents?
A. It does.
MR. CIRESI: Your Honor, we'd offer Exhibit 13182.
MR. BERNICK: No objection.
THE COURT: Court will receive 13182.
BY MR. CIRESI:
Q. Show the first page first, the routing system.
We go to the next page, please. And at the top we have the date, January 4th, 1980, and the title "OBSERVATION OF FREE NICOTINE CHANGES IN TOBACCO SMOKE."
Can you describe, doctor, what's being reported here in this document?
A. What the authors --
What the author did here was to compare several cigarette types side by side, discussing the

importance of pH and establishing their characteristics. They made several comparisons. For instance, the first one is between Marlboro 85 and Merit, and you see that the total nicotine that's delivered by the Marlboro 85 is 1.15 milligrams, and by the Merit cigarette it's .64. So there's almost half as much of nicotine delivered by the Merit cigarette than the Marlboro. But if you look at the last column, you'll see that the smoke pH for the Marlboro was given as 5.9 and the Merit as 6.4, which

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

is higher.
Because of the higher smoke pH, the percent of free nicotine is higher. You can see it's 50 percent in the Merit and in the Marlboro it's 28.7. And when you take that percent of the total nicotine delivered you'll see that what is presented is that the amount of free nicotine delivered by those cigarettes are essentially equivalent.
Q. Doctor, this document was prepared by Mr. C. F. Gregory, who was a lab supervisor, and it is sent to Mr. -- Dr. Sanford, who was the research and development director -- excuse me, the research director, to Mr. M. L. Reynolds, who was the research and development and engineering director, to Dr. Jewell, who was vice-president of manufacturing, to

Mr. Newton, who was the leaf processing division head, and to Mr. Riehl, R-i-e-h-l, who was the director of research and product development.
With respect to his communication to these gentlemen after looking at the Marlboro and Merit, what observation does Mr. Gregory make?
A. Well in that particular case he indicates that a person that's smoking either of those cigarettes, the Marlboro or the Merit, would not find appreciable difference in the physiological satisfaction from either as based on the fact that the amount of free nicotine delivered by the two are equivalent although they in fact deliver different amounts of total nicotine.
Q. If we go to the next page of this document, page two, does Mr. Gregory make a comparison at the top between raw product materials, those being flue-cured, and burley tobacco?
A. Yeah. There is a -- an indication -- or a comparison between a cigarette which is made of nothing but flue-cured tobacco, as I understand it, and one which is made of just the burley tobacco, and you'll see that the total amount of nicotine that's delivered by those two cigarettes as they prepare them, 6.13 and 6.33 milligrams, were similar.

On the other hand, you can see that the smoke pH is quite different between those two cigarettes, the burley being the more alkaline smoke, a pH of 6.81, and the flue-cured cigarette having the smoke pH of 5.48. As a result of that, there is a higher percent of free nicotine in the burley as opposed to the flue-cured, and this in turn gives rise to a considerably higher delivery of free nicotine in the burley relative to the flue-cured even though they both deliver essentially the same amount of total nicotine.
Q. And does Mr. Gregory then make an observation in the full paragraph below the comparison of the flue-cured and the all burley of test cigarettes?
A. Well he says, "As would be expected, a greater

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

impact and smoker reaction occurred with the all burley cigarette."
Q. And what -- what does he then report in the second paragraph?
A. It says, "These kinds of relationships" -- or "These relationships are not unknown to those persons developing new products in the tobacco industry," that is, its relationship between smoke pH, total nicotine delivery and free nicotine delivery. "We have seen many changes in these relationships at B&W,

such as through filter technology, use of chemicals, as well as conversion products formed from using tobaccos treated with microorganisms, to yield smoke with both increases and decreases in the free nicotine levels."
Q. And doctor, the third paragraph up from the bottom, does Mr. Gregory make an observation with respect to the knowledge that B&W has in this area?
A. It says that -- he's basically asking the question "Is there not some way open now to use the knowledge we have gained in this area of tobacco and smoke research to give B&W a competitive advantage over its competition? It appears that we have sufficient expertise available to, quote, build, unquote, a lowered milligram tar cigarette which will deliver as much, quote, free nicotine, unquote, as a Marlboro, Winston or Kent without increasing the total nicotine delivery above that of a "Light" product. There are products already being marketed which deliver high percentage, quote, free nicotine, unquote, levels in smoke, such as Merit" and "Now."
This is the realization that altering the form of nicotine in the face of an unchanged nicotine level provides more pharmacological impact than not, so the idea is that you can have a low tar cigarette,

and even though the nicotine may be low, you can have the functional equivalent of increasing it by increasing the pH, and therefore its free base concentration and the rate of transport to the blood, giving rise to the spiking effect in the blood, which is then delivered to the brain.
Q. Doctor, can you direct your attention now to Exhibit 10752. It would be in volume one. 10752. This is dated November 12th, 1984, it's entitled "Project SHIP." It is a review of a progress report from November 5th and 6th, 1984.
Have you read this document, doctor?
A. Yes, I have.
Q. And does it form part of the basis of your opinion in this case?
A. Yes.
MR. CIRESI: Your Honor, we'd offer Exhibit 10752.
MR. BERNICK: No objection.
THE COURT: Court will receive 10752.

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

BY MR. CIRESI:
Q. First of all, doctor, this references a meeting which number of people were present at, including Mr. Tilford Riehl, who was the head of research and product development, Mr. McMurtrie, who was the

director of product development, and Mr. Robin Crellin, who was from Group Research & Development Center in Southampton, which is in the U.K. So we see both Brown & Williamson and B.A.T at this meeting. It also references contributions from a number of other individuals including five doctors and another scientist, Mr. John Green. And if you turn to the back, the last page, it shows the circulation going to a number of individuals throughout the B.A.T empire, Hamburg, Germany, Brown & Williamson, et cetera.

MR. CORRIGAN: Your Honor, I move to strike that last statement, "B.A.T empire."

MR. CIRESI: The B.A.T family of companies. I'll rephrase it question.

THE COURT: That would be more appropriate, counsel.

Q. The B.A.T family of companies, Brown & Williamson and in Hamburg, Germany.

Can you turn to the first page, please.

MR. CIRESI: I apologize for that characterization, counsel.

MR. CORRIGAN: Thank you.

Q. The conclusions, can you tell us what's reported there?

A. Well they're talking about a project known as -- as SHIP, which had seven subprojects, which apparently were created in the spring of -- of that year, and the idea was to deliver answers within a time scale of six months. And then based on certain answers attained in that time scale, and provided that those answers were positive, the full program was going to be put into place, occupying the time of 12 to 18 months.

Q. Can you direct your attention, then, to page five of this document. It bears the Bates number 653.

A. Right. This was projects three and four of the seven projects, and they were searching to gain an understanding of the relationship between EBR technologies to PPJS and RCB, which refers to reconstituted sheets.

Q. And if we look at a) through h), what is the subject matter of their research?

A. Well they're interested in the nicotine scavenging from the lamina, which I've described. The nicotine transfer efficiency into the mainstream smoke. The free base vapor nicotine release from these materials. They're interested in nicotine filtration by the tobacco column and by the acetate

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

filters. The effect of pectin levels, which is a -- a -- a part or a component of the plant, the effect of pectin levels on nicotine manipulation. Thermal decomposition of nicotine pectinate, which is a salt formed between nicotine and pectin. And the thermal degradation of nicotine on high temperature release. That is, is it degraded? And the effect of nitrate levels on nicotine release.

Q. And if we page through the following pages, are each one of those sub -- subject matters discussed in this document?

A. Yes, a) through h). Each one has a short -- short summary about -- about the activity.

Q. And can you direct your attention first to page seven, paragraph c). And what is reported there?

A. Well this is the subproject dealing with free base/vapor nicotine release, and they point out that nicotine may be presented to the smoker in at least three forms, one is the salt form in the particulate phase -- and that would have been the one on my drawing that had the N and the H with the little plus sign. That's the salt form. And it's in -- when they say in the particulate phase, they are referring to the aerosol particle. It can be -- also be presented in the free base form in the particulate

phase -- that would be the letter N in our little drop -- the free base form of nicotine in the particle, or it can be presented in the free base form in the vapor phase, and that would be the little N that I drew outside the particle, the free base nicotine. And he says, "It has long been believed that nicotine presented as in (ii) and (iii)," which is the free base form and the particle -- particle phase and free base form in the vapor phase, "is considerably more, quote, active, unquote."

Q. And doctor, can you direct your attention, then, to the next page, subparagraph f), which addresses the subject of thermal decomposition of nicotine pectinate, and can you describe what's reported there, please.

A. Well these are preliminary studies that show that a nicotine-pectin mixture releases nicotine at a much higher temperature than the nicotine organic acid salts occurring in tobacco. Nicotine normally occurs in tobacco as a -- as a salt of a -- of organic acids, so as a consequence of this, maybe higher levels of vapor phase, free base nicotine in the smoke, again pointing to the intense interest in the emission of and creation of free base nicotine in cigarette smoke.

Q. And can you turn over to the next -- next page,

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://www.tobaccodocuments.ucsf.edu/docs/skhd0001

then, to see what else was looked at with regard to this subject matter.
A. Well they were going to do some experiments, it looks like, investigating nicotine salt pectin mixtures to establish the effect on nicotine release temperatures, and then to actually make measurements in cigarettes to establish the effect on both mainstream and sidestream nicotine yields.
The sidestream -- I don't know if that's a term we've used yet, but that's the smoke that is emitted from the cigarette when you're not puffing on it and it's just smoldering. And they also were going to evaluate nicotine flavor/acid mixtures, so this would be acids and nicotine together, to provide products with enhanced nicotine and flavor. "Thus nicotine itself might be used to stabilize certain volatile flavorants." So the idea was of maybe creating a -- a flavor package that involved nicotine and its ability to bind or sequester with these flavorants that were being added.
Q. And is the objective of these research projects stated at the last part of this paragraph?
A. It says it's -- the objective is the exploitation of the properties of nicotine and pectin

in the enhancement of smoke yields.
Q. Doctor, could you turn your attention now to Exhibit 10110, which is a Lorillard document which is now in evidence, the one we saw a few moments ago. And this is the one that was written by Leighton Chen. Do you recall this one, doctor?
A. Yes.
Q. Okay. Can you turn to the page after the one we were looking at earlier, had that graph on page ten, and under the title "Taste and Flavor" on page eleven, I'd like to direct your attention down to the last paragraph and then the brands that they have and the pH levels next to that.
What -- what's being reported here, doctor?
A. Well they're asking a question as to the importance of taste and flavor, and asking the question of whether or not a smoker smokes for nicotine or for flavor. And "This question must, at the same time, take into account the current trend toward low tar and nicotine cigarettes." They point out "If nicotine satisfaction were the only criteria, increasing the pH would be the obvious step. This, however, introduces a smoke with high physiologic impact and a harsh bite, which would seem to offset the advantages gained from increased nicotine.

Interestingly, the so-called flavor -- full flavor cigarettes should be assumed to have high physiological impact." And "It's probably no coincidence that these same full flavor cigarettes have the high pH's."
So they present a table which compares the

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://industrydocuments.ucsf.edu/docs/skhd0001

various cigarette brands and their pH's, and their comment on that is the market leaders appear to have the higher pH's, and hence, the higher concentration of free base nicotine, which is the same correlation that we've seen several times already today.
Q. And on the next page, do they lay out alternatives if the goal is to have increased nicotine yield?
A. It says it's basically two alternatives. If you want to have increased yield in the delivery of smoke, either you increase the absolute yield of the delivered nicotine, just put more nicotine -- make more nicotine available, or you increase the pH, which increases, they quote, "apparent nicotine content without changing the absolute amount."
So again we have them saying that a pH change is the functional equivalent of having changed the nicotine delivery.
Q. Now doctor -- I'm sorry. Please, continue.

A. So they look at these two things in -- in -- in rather equivalent ways, either increase the amount of nicotine that we're going to deliver, or change the form of nicotine, and we can accomplish basically the same thing.
Q. Doctor, yesterday we saw some documents regarding taste of nicotine, and I believe they said it was foul or rotten. Very apparent odor. Is that correct?
A. Yes.
Q. Okay. Now if you wanted to increase the kick of nicotine and you had two choices, one, add more nicotine, or two, alter its form, if you chose the former, what impact, if any, does that have on the taste?
A. Well one would expect that the more nicotine you deliver, the more the taste notes, if you will, of nicotine would come through in the -- in the smoke and the -- the poorer the perceived quality from a -- from a taste standpoint.
Q. And you talk about --
I think you said it's kind of like a recipe. Did your review of the documents of the defendants indicate anything with regard to how they look at this dichotomy between increasing the absolute

nicotine or changing its form?
MR. BERNICK: Object to the form of the question as lacking foundation. I -- I don't understand the question.
THE COURT: You may answer that.
A. Well they certainly did. The -- the formulation of a cigarette is a -- is a -- is complex, as we've seen, there's many materials that go into it, and each of those in some way will take a part in taste, sensation, the smoke experience in some way, and they all have to be brought into balance in order to have

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

an acceptable product. Now keeping in mind that nicotine is the material around which the cigarette revolves and its delivery is of key importance, that has now to be done in a format that provides the consumer with a palatable system. And we've seen that the nicotine can be manipulated both by amount or by form and its taste masked by the tar components and flavor additives that are brought to bear on the blend, and ultimately for every brand and for every cigarette that's made there is indeed a specification or a formulation, all the ingredients, just like a recipe, to make product X or product Y or product Z. And in some cases ammoniation may have been used, in other cases sugar reduction may have been used to

accomplish a pH change, in some cases both, in some cases there will be more ventilation, in other cases less, some cases there will be a longer cigarette and there will be a shorter cigarette. So all these come together finally and are assembled into the product, a product which generally, I think it's fair to say, has undergone consumer testing to see if there will be an acceptance, and then the product is marketed and launched and sold and provides a niche in the share of market that -- that exists. So there are products that cover the range of consumer acceptances, but all geared to deliver the nicotine in this dose-range window to the consumer.

Q. And does Dr. Chen address that precise recipe approach to the engineering of cigarettes on the last page of this document, page 13?

MR. BERNICK: Objection, leading.

THE COURT: You may answer that.

A. His closing statement, "One final question needs to be posed, that is, whether an optimal pH can be defined or targeted? In the absence of quantifiable predictors for consumer preferences relative to flavor and taste, a purely operational definition must suffice: the optimal pH is the pH in which the delivered smoke gives a perceived taste, flavor and

physiological impact most satisfying to the target market."

And that, indeed, summarizes all the factors that must go into making this a viable product by balancing all the many variables that come to bear in making this an effective and efficient and consumer-acceptable drug-delivery system.

MR. CIRESI: Your Honor, should we break there for the evening?

THE COURT: All right. We'll adjourn this evening and reconvene tomorrow morning at 9:30.

THE CLERK: Court stands in recess to reconvene tomorrow morning at 9:30.

(Court recesses.)

http://legacy.library.ucsf.edu/tid/mkn05a00/pdf Source: http://www.industrydocuments.ucsf.edu/docs/skhd0001

http://legacy.library.ucsf.edu/tid/mkp05a00/pdf
Source: https://www.industrydocuments.ucsf.edu/docs/skhd0001